SCIENCE

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CONTENTS

BOTANICAL GARDENS[1]

RELATIONS OF BOTANICAL GARDENS TO THE PUBLIC

Botanical gardens are important factors in public education, and are, at the same time, places for public recreation and enjoyment. They are highly specialized parks in which the plantations are formed and arranged primarily with regard to botanical facts and theories. Inasmuch as the great majority of their visitors have little time to spend, the information they carry away is more generally by impressions than by closer observation, although individual plants and groups of plants will often be remembered by casual visitors for long periods of time. Botanical gardens are, therefore, in effect museums of living plants, and the plants, treated as museum objects, suitably labeled, are installed to illustrate not only the objects themselves, but their relation to other objects. This museum feature is then a direct and immediate function in imparting information to the public.

The grouping of plants in botanical gardens is susceptible of widely different treatments, depending upon the character and the area of land available, the expense involved, and the facts and theories selected for illustration; also in the temperate zones, at least, upon the amount of greenhouse space available; also on the relative importance given to landscape considerations and upon the areas retained as natural forest, thicket or meadow. Facts and theories

[1] A symposium given before Section G, American Association for the Advancement of Science, at the Boston meeting, Tuesday, December 28, 1909.

capable of demonstration may be grouped in a general way as (1) biological relationships, (2) morphological and physiological features, (3) economic applications, (4) geographical distribution, (5) esthetic and landscape features. Practical considerations enter largely into groupings of any kind.

1. *Biological Relationships.*—In this installation it is sought to illustrate species of the various plant families in juxtaposition, the groups thus formed being located in relation to each other in some predetermined sequence; this sequence in recently planted botanical gardens is usually one which seeks to demonstrate not alone affinity, but the progressive increase in floral complexity, in other words, an evolutionary sequence. In such installations practical considerations render the sequence necessarily incomplete in any one set of plantations; sunshine-requiring herbaceous plants and shrubs can not be successfully grown close to trees, and some natural families, such as Papilionaceæ and Rubiaceæ contain herbs, shrubs and trees; climatic considerations prevent many families being brought into any one sequence; the biological grouping must then be obtained piecemeal; the most satisfactory and least expensive method is to grow the collections of trees (arboretum), of shrubs (fruticetum), of vines (viticetum), and of herbaceous plants, for the most part, at least, in separate areas; families principally composed of plants inhabiting climates other than that of the locality require artificial environment, such as glass houses for tropical and warm-temperate zone plants in gardens of the cold-temperate zone; it would be an interesting experiment to ascertain if arctic plants could be grown successfully in the temperate zones by some system of refrigeration. By a suitable arrangement of land and water, aquatic plants may be brought to some extent into juxtaposition with those of the same or related families requiring dry soil. One advantage in the biological grouping of large collections is the facility with which any species represented may be found when wanted. By the formation of a museum of prepared plants, of fruits, seeds and other organs, of photographs and drawings, the biological sequence adopted may be quite completely illustrated.

By indicating on the labels the native regions of plants biologically grouped, much simple information bearing on geographic distribution may be given. Casual observers are often as much interested to learn where a plant came from as to learn if it has any useful or ornamental features; the biological grouping also teaches them, by suggestion, that plants even from remote regions are related to other plants which they may know something about, and thus opens up new lines of thought for many people.

2. *Morphological and Physiological Features.*—The demonstration and illustration of structure and function presupposes some acquaintance with elementary botany, which the great majority of visitors do not at present have. The rapid development of nature-study in schools will render groupings of plants, arranged from these standpoints, much more generally significant than they are at present. It is possible and practicable to form groups of plants selected to illustrate the gross morphology and the simpler phenomena of physiology. These groups are more likely to be elaborated in gardens established primarily for students than in those laid out primarily for the use of the public. To a certain extent groupings illustrating ecological considerations can also be established with advantage, although areas remaining in the natural state are more useful.

3. *Economic Applications.*—Plants grouped and labeled with reference to their uses, or the uses of their products, are of very direct interest to the public, coming, perhaps, closer to ordinary lines of thought than any other features of the vegetable world, except those of beauty. The arboretum illustrates the subject of forest products without the necessity for a separate grouping of trees. Economic features of shrubs and herbaceous plants are best brought out by a special installation classified as food plants, drug plants, fiber plants and otherwise. As in the case of systematic grouping, economic installation has to be piecemeal, using glass houses for tropical economic plants and for those from warm-temperate regions. The elaboration of labels is of great importance and is, perhaps, the most expensive feature in the satisfactory display of useful plants. These subjects can be very thoroughly illustrated by the formation of museums of economic plant products and this is usually accomplished in highly developed botanical gardens. A system of cross references on labels between the living collections and the museum collections is a great desideratum. The expense of such a system is, however, very great, and it requires constant attention, because the death of a living plant, which can not at once be replaced, complicates it.

4. *Geographical Distribution.*—Groups of plants illustrating the botanical features of regions other than those of the locality of a botanical garden may be installed and this feature is given more or less prominence in the collections of many gardens. As mentioned under biological relationships, the information thus furnished is of immediate interest to the public and in some gardens geographical grouping has been adopted as a primary classification. Like the biological grouping, it has its limitations, and conditions of soil and climate make it necessarily imperfect and incomplete. Any attempt at growing trees, shrubs and herbaceous plants of a region close together in limited areas, while at first very interesting, ultimately fails because of the growth of the trees and the consequent shading out of the lower plants, unless the trees are cut out and their value in the grouping lost. Climatic conditions may be overcome by temporary geographical groupings, and in greenhouses some such groups may be installed quite satisfactorily. As to the relative value of the biological over the geographical as a primary classification in large public gardens, there is room for difference of opinion. An ideal method, if space and funds are available, would be to install both systems.

5. *Esthetic and Landscape Features.*—The public is more immediately interested in landscape effects and in plants from the standpoint of beauty than in most other features of botanical gardens. Well-built and well-kept grounds appeal to people as attractive places to visit. Natural woodlands, thickets and meadows also interest visitors, perhaps more keenly the residents of cities, and in some respects, especially from the standpoint of ecology, are as useful educationally as the artificial plantations. Landscape considerations applicable to parks and private grounds are not wholly adaptable to botanical gardens and this is often notably true in the unharmonious floral color contrasts necessitated by the grouping, although these may be minimized by careful selections. In most botanical-garden planting it is sought to display the plant in its natural form, so that extensive massing of individuals is avoided, although in large gardens space is often available for both massed and open planting. In the grouped plantations incongruous elements should be avoided, such

as establishing herbaceous flowering plants in plots among collections of trees and shrubs, which would divert attention from the main installation, or the introducing of exotic species into natural woodlands and thickets, which would give the public erratic ecological conceptions. Flower gardens, as such, are generally located separately from the botanically grouped plantations, for in them esthetic considerations are predominant.

The popularity of botanical gardens causes them at times to be over-crowded and problems relative to the control and circulation of large numbers of people arise which have to be met as well as possible. A comprehensive system of paths is essential; the majority of visitors instinctively keep to the paths, but it is undesirable in large gardens, at least, to actually restrict visitors to paths, for they could then come close to only a relatively small number of the plants installed, unless the path system was unduly elaborated and landscape considerations wholly neglected. A very small proportion of the public is intuitively destructive, and it is this small number of people that entail high expense for guards and keepers; legal punishment of offenders as a warning to others of mischievous proclivities is the only treatment available. In large gardens a driveway system and provision for conveyances for hire are also desirable, for many visitors are unable or unwilling to walk considerable distances.

The indirect relation of botanical gardens to the public lies in their function of adding to the knowledge of plants and plant products and the diffusion of this knowledge by publication and otherwise. Laboratories, herbaria and a library are essential adjuncts to the garden itself, and through investigations carried on in them and in the garden, additions to knowledge are constantly made. Of these additions to botanical information those of an economic character are the most immediately available for the public good, but the more theoretical additions to information may prove the more important in the long run.

From what I have said it will be clear that the function of botanical gardens in their relation to the public is somewhat different from their relations to college and university students, although, after all, this difference is one of degree rather than of kind.

N. L. Britton

THE PLACE OF BOTANICAL GARDENS IN COLLEGIATE INSTRUCTION

The splendid gardens under the direction of my predecessors in this discussion are well known to everybody, but this can not be true of the modest one of which I have charge. It will therefore be fairer to my comments on the subject if I say that it has been my duty, during the past fifteen years, to develop at Smith College, with due regard to reasonable financial restrictions, a garden which should be as well adapted as possible to collegiate instruction. It now includes these parts. First, there is an arboretum and fruticetum, of some 500 species, distributed, with regard partly to scientific arrangement and partly to pleasing landscape effects, over a campus of some thirty acres. Second, there is an herbaceous garden of some 700 species, arranged on the Engler and Prantl system. Third, there are three natural gardens, a rock garden, water garden and wild garden, the last as yet too young to be effective. Fourth, there is a range of well-built and suitably stocked greenhouses, nine in number with two attached laboratories. Upon the development of this garden rests my qualification for the part I have in this discussion. Naturally, it approximates to my idea of what a college botanical garden

should be. I wish to ask you to bear in mind that I speak upon gardens in collegiate instruction, and I shall keep strictly to that subject. Many of my conclusions do not apply at all to gardens of a different type—public, university or other.

Colleges differ much from one another in many features, but from our present point of view have these in common: First, they have only an undergraduate constituency, with practically no graduate work. Second, they have extensive grounds, usually of a rural character, which it is desirable to make as beautiful as possible. Third, they have a long summer vacation, with no summer schools or other instruction in that time. Of these conditions, to which collegiate botanical gardens must be adjusted, I shall speak in reverse order.

The long summer vacation is even longer, from the present point of view, than its number of weeks implies, for most of our students do not know enough to make profitable use of the garden at the opening of college, while the great number of social and other distractions at the end of the college year, not to mention the attractions of the native flora, seriously shorten its period of usefulness in the spring. Consequently the part of a botanical garden of most use in a college is that in which plants are alive and at work during the winter months, viz., the greenhouses. There is no question that, so far as scientific instruction in a college is concerned, suitable greenhouses are far more valuable than any outdoor garden.

Yet the long summer vacation does not by any means empty a college garden of its utility or desirability. The part which the vacation renders least useful is the herbaceous garden, arranged on the systematic plan, and I am not sure but that, if I were starting all over again, I would omit this part, closely identified though it is with the very idea of a botanical garden. Another kind which the long vacation would render of slight use is an ecological garden, that consisting of beds designed to illustrate types of structure, of dissemination methods, of cross-pollination mechanisms, and the like, for these would be well-nigh useless in early spring and late fall. Indeed, such observation and limited experimenting as I have been able to make on such beds leads me to disbelieve in their value aside from this limitation. It is impossible to have many of the forms illustrative of a certain idea in good condition at the same time; many of the forms best illustrating an idea are otherwise very unattractive and often difficult to grow; and even when such beds are developed, there are few people who can understand them unless they already know the subject with some thoroughness. I think it is usually true that gardens prepared to illustrate any artificial plan or idea, whether ecological, historical (*e. g.*, plants mentioned by Shakespeare) or other, are very unattractive in appearance and difficult to maintain effectively. These objections do not apply to natural gardens, viz., rock gardens, water gardens, wild gardens, in which plants are grown in natural surroundings; for these plants and places can be made so attractive as to draw appreciation and notice from all, and when suitably labeled, as of course all parts of the garden must be, they are decidedly instructive. We have at Smith College a very attractive rock garden, with a variety of exposures, containing many kinds of plants, from cliff dwellers to shade-loving ferns, and it amply repays its cost in the pleasure and the instruction it gives to its many visitors.

Another part of the outdoor garden that is well worth while despite the long vacation is the collection of trees and shrubs, especially as these are needed for the beau-

tifying of the grounds, which must receive attention whether a true botanical garden is developed or not. And this brings me to the second of the three conditions which must be met in collegiate gardens. All colleges desire to have their grounds as beautiful as possible, in order to create attractive surroundings for undergraduates, pleasing memories for graduates and favorable impressions for parents and benefactors. Now, to this end, the extensive use of trees and shrubs is indispensable. It would seem at first sight possible to combine a good landscape use of these with a systematic arrangement to illustrate relationships, but I have found, as no doubt have many others before me, that this is only partially possible. Thus, some families contain far more plants of attractive form than others. Imagine confining Coniferæ strictly to one section! Again, the proportion of trees to shrubs is so different in the various families that if these were confined to special areas some sections would have few or no trees and others no shrubs. Thus Leguminosæ have several ornamental trees, but hardly any ornamental shrubs, while this case is reversed in Rosaceæ, reaching an extreme in Caprifoliaceæ, which has no ornamental trees at all. Hence a strictly systematic arrangement can not be combined with good landscape results, and the best that can be done is to make sure that representatives of a given family are present in the appropriate area, even though not confined thereto. But on this plan, a very good collection of trees and shrubs, both pleasing to the eye and useful for study, can be assembled on a college campus. Moreover, trees and shrubs are in condition for study earlier in spring and later in autumn than herbaceous plants, and besides can be studied to considerable advantage all through the winter when herbaceous plants are not visible at all. Hence my experience has shown that of the outdoor garden, the trees and shrubs are far and away the most valuable part; next come natural gardens, and last of all the systematic garden. There is one other matter worth mention in this connection. The absolute necessity which colleges are under to keep their grounds attractive in any case, makes it possible to develop them as a botanical garden with comparatively little additional expense, for the extra cost of the other features is not relatively great. This applies in part also to the greenhouses, because where these are developed it is possible to give profitable and congenial employment to a good gardener during the winter, and consequently a more competent type of man can be kept, to the great advantage of all the interests involved.

Another matter which I am finding important in connection with the outdoor garden, but which applies equally to the greenhouses, is this. It is far better to concentrate upon good effects with a few things rather than upon the collection of many. In my own garden, we are reducing the number of species, but are giving better massing and surroundings to those we retain, which include especially the kinds the observer is likely to meet with again. Primarily this is in order to conform to an educational principle of which the importance steadily grows upon me, viz., that the scientific merits of a garden, or of anything else, are not of themselves sufficient to attract persons to their study, but attention must be paid to the peculiarities of human nature which demand that things shall be made attractive also. I therefore consider it important to so arrange plants that they will evoke attention and admiration first, on which basis instruction is far more easily given. And as the human capacity for attention and absorption is strictly limited, it is no use to

try to produce many such pleasing effects. A few very pleasing trees appeal more to human nature than do many only moderately pleasing. This principle fits perfectly, also, with my first condition of college instruction above mentioned, that only undergraduates make use of the garden, and the number of kinds they can utilize is not very great. In all scientific institutions, whether gardens, museums, or courses of instruction, we seem to pass first through an accumulation stage, in which completeness is the ideal and we try to collect all the kinds we can. Later we pass to a selection and individualization stage, in which we pick out the most essential objects and give each an ample and distinctive setting. We have passed into the second stage in our museums and to some extent in our instruction, but hardly yet in our botanical gardens.

I pass finally to the greenhouses, the importance of which I can not too strongly emphasize. These should be arranged, for convenience of both use and management, upon a climatic basis, including cool temperate, warm temperate, desert, stove and palm houses at least, furnished with a selection of well-labeled plants of the chief scientific interest, and with room for the growing of class material and for horticultural and physiological experiment, while the closer the attachment of the greenhouses to laboratories the better. I am here, as you may suspect, outlining the arrangement of the range developed under my charge, the practical working of which is extremely satisfactory.

The educational advantages of good greenhouses are too well known to all to need comment, but I may add another advantage not so obvious, viz., that they provide an extremely attractive and instructive place for visit in winter, not only by students but by their friends and visitors; and this is something of marked advantage in rural communities. Indeed, the instruction and enjoyment derived by the public from outdoor gardens as well as greenhouses constitute no small reason for their development. For not only do they attract attention and sympathy to a college, but they are also a wholly appropriate and serviceable form of college extension.

There are two warnings I would sound in connection with the greenhouses. First, they should be kept free from all entanglements in connection with the supply of ornamental plants for college functions. Such a use is bad for the plants, subversive of a scientific interest in them by the gardeners, and derogatory to the reputation of the greenhouses. The respect of the college community is far greater for a collection of plants kept exclusively for educational purposes, and for the scientific interests involved therein, than for any collection at their beck and call for social purposes. Second, they should be kept free from any attempt to make them help pay their own cost. The florist business is a highly specialized one, conducted, as a rule, on a narrow margin of profit, and no range of college greenhouses can earn any considerable amount without devoting thereto an amount of space and gardener's time wholly incompatible with any considerable attention to educational objects. Moreover, the feeling of local florists is quite sure to be aroused against an institution conducting a competition which they are sure to regard as unfair. These objections do not apply to the greenhouses of agricultural colleges; where the problems are different, and where it is essential that the students learn to raise plants for profit.

So, I may summarize my ideal botanical garden for a college by saying that it consists first of a good range of greenhouses, second of a collection of trees and shrubs,

primarily grouped artistically and secondarily on a systematic plan, third of natural gardens, and fourth of a limited systematic herbaceous garden. In all, selection and attractiveness of setting should be controlling principles.

W. F. Ganong

A UNIVERSITY BOTANICAL GARDEN

It requires some presumption for a mere novice to talk on this theme, after the fathers of our great botanical gardens have spoken from their ripe experience. One who neither grew up in a botanical garden already established, nor has had time to grow far with one established but a short two years ago, can hardly be expected to speak with authority. My only justification for complying with the request of your secretary to participate in this discussion is the fact that, in planning the botanical garden for the Johns Hopkins University, I have discovered what a goodly number of problems confront the beginner in this kind of work and how little detailed information is to be found in print that will aid him to overcome them.

I may therefore, perhaps, be permitted to say something of the purpose of our garden, of some of the difficulties encountered, and of such solutions of these, or part of them, as have either been worked out at Homewood or gathered from the experience of other gardens. These things are said not only in the hope of being of service to others who may be planning gardens, but also of evoking from others helpful criticism, that may be of aid to us in the work at Homewood.

That a botanical garden can be of great value to university students does not stand in need of proof to you of this audience. I desire, however, to suggest some of the particular ways in which I believe it may be most useful. If university students are what they should be, in aim and industry, it seems evident that access to a well-arranged botanical garden may advantageously replace class-room courses on certain aspects of gross morphology, floral biology and floristic geography, besides greatly enhancing the value of many of the formal courses on other subjects, given in lecture room and laboratory.

A botanical garden which is to be of use in the ways mentioned must suggest clearly what it is intended to illustrate. It must leave no suspicion of the aimlessness of a "cabinet of curiosities," but must show the purposefulness of a skilfully arranged museum—a museum in which (as an able museum director has said) the carefully selected specimens illustrate a well-devised series of labels, rather than one in which the labels are mere name-tags for more or less accidentally acquired specimens.

Such a definitely planned garden can well serve to extend the laboratory work and to concentrate the field work. For in the laboratory a student can not study enough plants minutely to comprehend them broadly; in the field he can not study any plant so thoroughly as to understand it deeply. The garden renders a larger variety of plants accessible, brings plants of different regions together for ready comparison, taxonomically, morphologically and physiologically, makes it possible to observe their activity and development more continuously and, finally, gives the most satisfactory opportunity of preserving them at critical stages for future study and comparison. The garden then does not replace either field or laboratory, but it does effectively link them.

If now we consider more specifically the functions a garden may serve we may summarize them thus:

1. It can illustrate certain phenomena of plant life which may be observed directly,

as the plants grow in the garden or the accompanying greenhouse. Because they can be observed continuously the student gains a familiarity with them and their phenomena which is not possible from a single contact with them, when they are brought out once a year, in a laboratory course.

2. The garden and greenhouse have an important use as a source for the material needed in instruction and research, in laboratory and herbarium.

3. The existence of a garden insures the presence of propagating grounds, tools and a trained gardener, all of them necessary to the carrying on of researches in plant breeding or other work involving extensive cultures, such as are often made in studies of variation and experimental morphology.

4. Not the least important feature of a garden, especially one on a university campus, is that it shall prove attractive from its design and the plants in it, entirely aside from its scientific interest.

I shall, from this on, make casual reference only to the last three of these functions, but shall dwell more fully on the first, *i. e.*, the use of a garden in botanical instruction. This is, I believe, the function which chiefly determines the arrangement of most botanical gardens now in existence, the only other potent influence being, perhaps, the artistic one.

The botanical facts and principles that can well be illustrated in a botanical garden may be grouped under the following heads: (1) plant structures, (2) plant phylogeny, (3) plant activity or physiology, (4) plant ecology, (5) floristic plant geography, (6) economic plants. We may now take these up in the order mentioned.

1. Plant structures may be illustrated by examples, first, of vegetative organs, in their various modifications, and secondly by examples of reproductive organs, such as those for vegetative multiplication, for asexual reproduction, and for sexual reproduction, including such accessory reproductive organs as flowers and fruits.

2. Plant phylogeny may be illustrated by the natural system of Engler, as a modern interpretation of the kinship of plants, also by selected examples of older "natural systems" of historical importance, such as the systems of Jussieu, Braun and Eichler. Finally, examples of plant breeding may be made to illustrate the means of origin of new types of plants, such as sports, mutants and hybrids.

3. Types of plant activity that may be readily illustrated in a garden are: first, those connected with growth—showing its rate, direction and seasonal variation; secondly, sleep movements; thirdly, movements of leaves of compass plants; fourth, the movement of irritable or sensitive leaves; fifth, and finally, those movements of the flower, or its parts, which aid in the process of pollination, of which many interesting examples may be shown.

4. In plant ecology we may well illustrate certain important habitat-relations and growth-forms. Those that can be most satisfactorily shown are chiefly relations to edaphic factors, though the alpinum and the greenhouse give some opportunity of suggesting relations to climatic factors. Other ecological facts may be illustrated by examples of plant communities. Under this head, when enough ground is available, may be shown plant formations, chiefly native ones, as forest, bush, meadow, etc. Finally, ecological guilds, or types of symbionts, may be illustrated by lianes, epiphytes, saprophytes and parasites. This latter series takes but little space in the garden, but much ingenuity is required to make them develop typically.

5. Floristic plant geography may perhaps be best illustrated not merely by

groups of plants from the different formations of a general floristic region, but also, where space permits, by like formations from different regions. These should be as complete as possible and may well be selected to show similar growth-forms occurring in widely different species, genera, or even families. In Atlantic North America, for instance, bits of Alaskan, Manchurian or Scandinavian forest, in which all the elements from the herbs of the forest floor to the dominant trees are represented, would prove exceedingly interesting for comparison with our native forest and with each other.

6. Economic plants may be represented by those plants which yield the chief vegetable products of commerce, by types of ornamental plants and by noxious plants, *e. g.*, weeds, poisonous plants and fungus parasites. The practical application of plant breeding may also be illustrated here by examples showing the difference often existing between the wild parent and the cultivated offspring, together with illustrations of the methods of breeding and cultivation by which the modification of cultivated types is produced.

These, I believe, are some of the facts and principles which we may hope to illustrate in a botanical garden. The realization of these expectations demands, I am finding, persistent industry and unfailing optimism, for obstacles arise unexpectedly, and success in new fields is far from certain.

In the garden of the Johns Hopkins University, at Homewood, we are trying to do some, at present not all, of the things which I have just outlined. I wish now to try to tell you just what these are, how we have planned them and something of the practical expedients by which we have managed to get plants to grow where we wish them. I may also refer to the devices for labeling which are being used, in the attempt to make the garden intelligible not only to the student, but also to the general public, to whom the garden is open.

The area at present planted at Homewood, the new university site, is a flat-topped knoll, about two acres in extent, surrounded on three sides by a native forest of oak, chestnut, beech and tulip. The garden is laid out in a strictly formal manner, in view of the fact that it is to form the western termination of the transverse axis of the proposed group of university buildings. It will ultimately be overlooked by the terrace on which the westernmost buildings are to be located.

The boundary of the garden is marked by two parallel lines of hemlock hedge with a wide walk between them. The entire garden is divided into quarters by walks running from the middle of each side to a large pool in the center. Each quarter is broken by gravel walks into 18 beds with myrtle borders. These beds contain altogether about 500 planting spaces ($2\frac{1}{2} \times 3\frac{1}{2}$ feet), making something over 2,000 planting spaces for the whole garden. The greenhouse, physiological laboratory and an acre of ground for propagating purposes lie directly south of the garden.

The garden consists of four sections. Section I. illustrates the chief types of vegetative organs of plants. The arrangement of these types is in part a morphological, in part a biological one. Section II. is given to the illustration of the structure and biology of the reproductive organs of plants, *i. e.*, of sporangia, flowers, seeds, fruits, etc. Section III. illustrates the genealogy of plants as indicated by their classification. It includes illustrations of the various kinds and degrees of kinship, of species, genus and family, of hybrids and mutants, of a number of historically important systems of classification and of

the modern system of Engler. Finally, it also illustrates in some detail the variety in structure and in geographical distribution, found among the members of a few selected families of seed plants, *e. g.*, of Ginkgoaceæ, Saururaceæ, Liliaceæ and Compositæ. Section IV. contains a selected series of useful and of ornamental plants, chiefly those native to temperate regions, though a few of the more important tropical, economic plants are shown.

In the further development of the botanical garden it is planned to illustrate various types of plant communities, some of the important facts of geographical distribution and the habitat relations of various growth-forms. It is expected that the general planting of the Homewood grounds may be carried out in such a way that the groups of shrubs and trees so used shall have scientific as well as an ornamental value.

The efficiency of a garden as an educational factor is determined, in large degree, by the design and arrangement of the labels used to designate the individual plants and the plant groups shown.

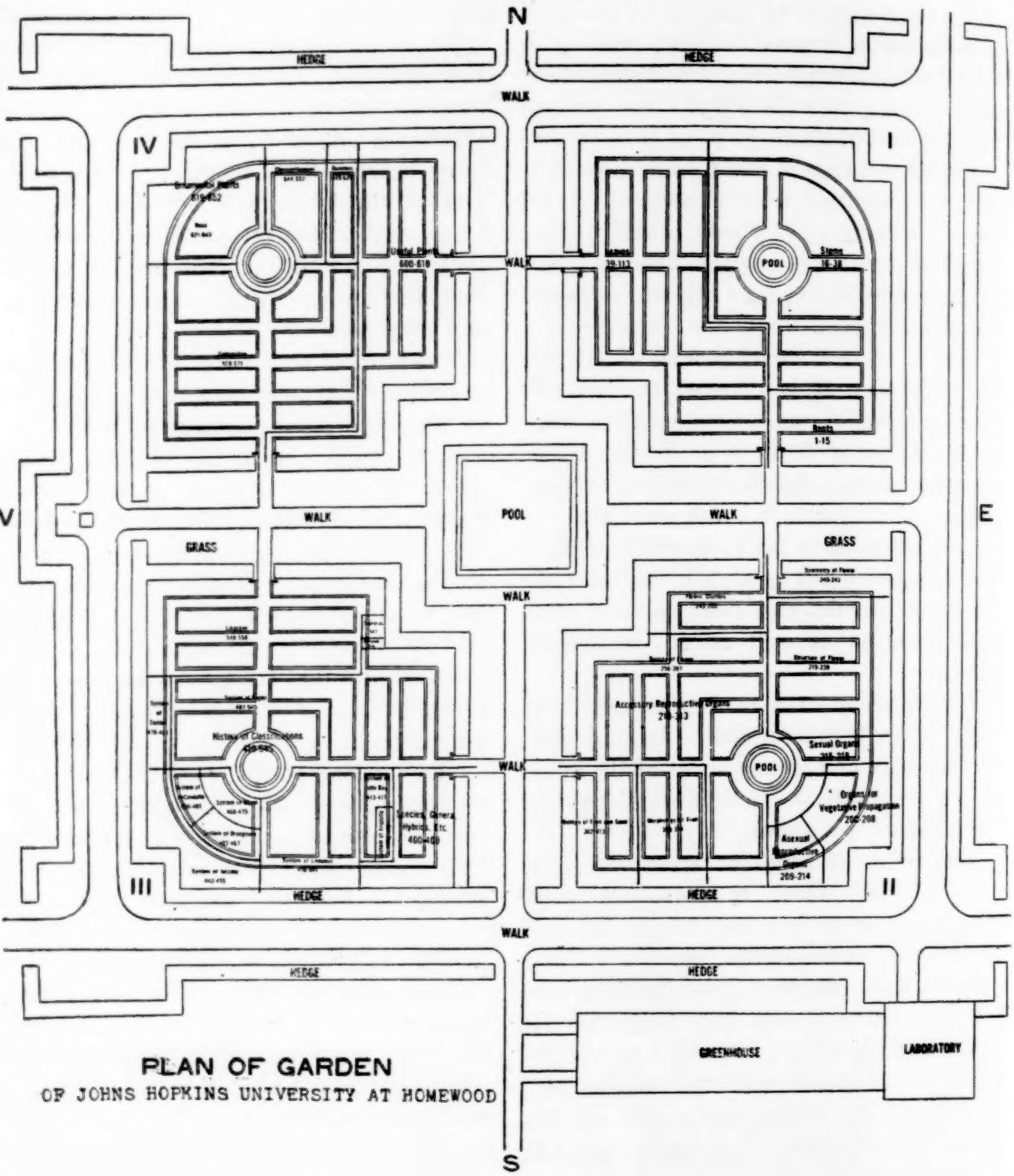
The series of types of structure, relationship, etc., shown in each section of the garden at Homewood, is divided into successively subordinate groups. These groups are: division, subdivision and groups without names but designated by letters and signs.

Each individual type of structure, etc., is designated, in this guide and on the labels, by a number. All species used in the garden to illustrate a given type bear the number of this type on their labels. In the guide this number is found at the extreme left of the page, opposite the name of the group. In the garden these numbers are at the bottom on the group labels and at the top on the species labels.

The numbers at the bottom of a group label indicate the kinds and number of types of structure included in the group. For example: the numbers 16–19 on the label for subterranean stems indicate that the types included in this category are those bearing these numbers, in the guide and on the labels, *i. e.*, rhizomes, tubers, corms and bulbs; the numbers 288–290 on the label for indehiscent fruits indicate that this group includes the achene, nut and caryopsis.

The number at the top of a species label indicates the type of structure, relationship or economic plant illustrated by this species. A reference to this number in the guide, or in the garden, to the nearest group-label bearing this number, shows what is illustrated by the species. For example: any species label bearing the number 8 indicates that the plant illustrates the use of the roots as tendrils; the number 529 indicates that the species belongs in the series Rosales of Engler; the number 600 designates the species as a cereal.

The location in the garden of the illustrations of any particular group of structures or relationships may be readily seen by a comparison of the outline of the chief groups (p. 653) and the plan showing the arrangement of beds in the garden (figure, p. 652). On the latter the area devoted to each division is indicated by heavy lines between beds. Section I. is in the northeast quarter of the garden, the types being numbered from 1 to 113. Section II. is in the southeast quarter (Nos. 200–313). Section III. is contained chiefly in the southwest quarter (Nos. 400–558), but partly in the northwest quarter (Nos. 559–571). Section IV. is also contained in the northwest quarter (Nos. 600–652). The sequence of the types within each quarter is readily seen from the numbers on the labels. These are arranged in regular succession along the beds as far as possible,



PLAN OF GARDEN
OF JOHNS HOPKINS UNIVERSITY AT HOMEWOOD

and, where this succession has been broken, an index label has been used to show where the next following numbers are to be found.

By means then of the continuous series of numbers, one for each ultimate unit of structure or relationship shown, it is believed that confusion may be avoided and the visitor be at liberty to note as much or as little as he desires of the assembling of these units into successively larger groups, which are indicated in the guide, and by group labels in the garden.

With such a definite series of structures

BOTANICAL GARDEN AT HOMEWOOD

CHIEF GROUPS IN THE GARDEN

SECTION I. VEGETATIVE ORGANS.
Division I. Roots. 1–15.
Subdivision I. Subterranean Roots.
" II. Aquatic Roots.
" III. Aerial Roots.
" IV. Parasitic Roots.
Division II. Stems. 16–38.
Subdivision I. Leafless Stems.
" II. Foliage Stems.
" III. Branch Systems.
Division III. Leaves. 39–113.
Subdivision I. Cotyledons.
" II. Foliage Leaves.

SECTION II. REPRODUCTIVE ORGANS.
Division I. For Vegetative Propagation. 200–208.
" II. For Asexual Reproduction. 209–214.
" III. For Sexual Reproduction. 215–313.
Subdivision I. Sexual Organs.
" II. Accessory Reproductive Organs.

SECTION III. PLANT RELATIONSHIP.
Division I. Degrees of Relationship. 400–409.
" II. History of Classifications. 410–545.
Subdivision I. System of Aristotle.
" II. " " Ray.
" III. " " Linnæus.
" IV. " " de Jussieu.
" V. " " de Candolle.
" VI. " " Brongniart.
" VII. " " Braun.
" VIII. " " Eichler.
" IX. " " Engler.
Division III. Selected Families. 546–571.

SECTION IV. ECONOMIC PLANTS.
Division I. Useful Plants. 600–618.
" II. Ornamental Plants. 619–652.

OUTLINE OF THE TYPES OF PLANT ORGANS, OF PLANT RELATIONSHIPS AND OF ECONOMIC PLANTS ILLUSTRATED IN THE GARDEN*

SECTION I. VEGETATIVE ORGANS.
Division I. Roots.
Subdivision I. Subterranean Roots.
1 Tap Roots.
2 Fascicled Roots (clustered roots).
3 Fibrous Roots.
Subdivision II. Aquatic Roots.
4 Bottom Roots.
5 Floating Roots.
Subdivision III. Aerial Roots.
6 Prop Roots.
7 Protective Roots (root-thorns).
8 Tendril Roots.
9 Attaching Roots (of air plants).
10 Attaching and Absorbing Roots (of air plants).
Subdivision IV. Parasitic Roots.
11 Water-absorbing Roots.
12 Food-absorbing Roots.
Subdivision V. Symbiotic Roots.
13 Mycorhizal Roots (with fungus threads instead of root hairs).
14 Bacterial Roots (with bacterial tubercles).
15 Nostoc-holding Roots.
Division II. Stems.
Subdivision I. Leafless Stems (*i. e.*, with scale-like leaves).
A. Subterranean Stems.
16 Rhizomes.
17 Tubers.
18 Corms.
19 Bulbs.
B. Aerial Leafless Stems.
20 Cactoid Stems (fleshy green stems).
21 Phylloeladia (leaf-like stems).

* All types illustrated in the garden are indicated in this list. Each type is given a number here, which also will be on the top of the label of every species used to illustrate that type.[1]

and systematic sequences to be illustrated in a set of formal beds, we encounter at once the very practical difficulty of making plants grow in proximity in the garden that occupy quite different habitats in nature. Under these conditions one is tempted to do what one of my correspondents has done—*i. e.*, rearrange the families of plants in such a way that families with like habitat-requirements come near together. This correspondent, a landscape gardener, points out the horticultural inconveniences of the Engler system, and suggests that the Eichler, and Bentham and

[1] This page is reprinted from "Guide to the Botanical Garden at Homewood."

Hooker systems are—to quote—"better adapted to the artistic ensemble of a hardy garden." He then proceeds to give—to quote again—"a revision of the Hookerian cohorts that is adapted to copyrighted garden plans of the author previously published."

If, however, one is not bold enough to remodel the whole natural system to suit his particular garden scheme he must find other means of making system and soil fit—and this often presents considerable difficulties.

To make aquatic and bog plants grow beside related forms inhabiting drier soils, we tried several devices. The first of these was the small brick pool common in European gardens. But these are expensive to build and are liable to be burst and rendered useless by freezing. We have, therefore, substituted two-gallon earthenware kitchen bowls, with sloping sides inside and out. These can stand freezing, and can be made invisible in the garden by sinking them to the rim in the soil. Well-developed specimens of many aquatic plants were made to grow in these during the past summer. By the use of these bowls it is possible to have a miniature bog at any point in the garden where it is needed.

Provision for larger aquatic plants is made by three concrete pools. For swamp plants there is a bog bed, 15 × 30 feet, filled with peaty soil. This has a water-tight brick border, two feet deep, and a water supply from taps at both ends. In this bed fine specimens of *Woodwardia virginica, Rhododendron viscosum, Hibiscus moscheutos, Decodon verticillatus* and others have flourished finely.

In a bed of sand, with a slight admixture of humus, fine clumps of *Opuntia vulgaris* are spreading vigorously and other xerophytes promise to do well.

Another difficulty encountered in garden-making of this sort is that of getting shade plants to grow in the open beds. To accomplish this we have been using small dogwoods, which can readily be kept within bounds, and in the shade of which many mosses, ferns, orchids and other plants of the forest floor are growing well.

Finally, a very important detail of the management of a garden is the selection of labels that shall be inexpensive and at the same time legible and durable. Profiting by suggestions from older gardens we have devised three types of zinc labels that are proving very satisfactory. The simplest of these is a stake label an inch wide and six inches long. On this the accession number is stamped across the top with a steel stamp, and the name is written directly on the metal with platinum tetrachlorid. These labels are used for all plants not provided with show labels. Another type of label is $1\frac{3}{4}$ inch wide and 8 inches long. It is painted gray, the name is then stamped on it with printer's ink by means of a rubber stamp. After the ink is dry the label is covered with spar varnish. These are used for show labels on pot plants in the greenhouse. The show labels used for all group and species labels in the garden are rectangular zinc labels, of various sizes from 3 × 5 inches up to 5 × 12 inches. These are hung by a fold of the upper edge, to a heavy wire staple, the name is printed and the varnish used for protection as in the show labels in the greenhouse.

The advantage of these labels is that they can be made readily, of any size, by any tinsmith, since they do not involve the use of expensive dies.

Such are some of the practical devices which contribute toward making the garden useful. Some of these are probably used in other gardens, but I have thought it worth while to mention them here be-

cause I have not been able to find information of this sort in print.

It is to be expected that what now seem satisfactory devices for carrying on the work of the garden will prove capable of much improvement in the future, aided by experience gained from other gardens as well as in our own. It will always be one of the chief aims of the garden at Homewood to discover what a garden is capable of doing for the botanical student and investigator and how it can do this best.

DUNCAN S. JOHNSON

THE RELATION OF APPLIED SCIENCE TO EDUCATION [1]

THE dative of indirect object is used with most Latin verbs compounded with ad, ante, con, in, inter, ob, post, pre, pro, sub and super, and sometimes circum; the elements essential for the growth and maturity of the plants which furnish, directly or indirectly, the food and clothing for the human race are carbon, hydrogen, oxygen, nitrogen,. phosphorus, potassium, magnesium, calcium, iron and sulfur, and possibly chlorin, and I think I am expected to discuss the general question whether there may be as much educational development in a study of these elements, for example, and of their application to the preservation of American soil and to the preservation of American prosperity, civilization and influence, as in learning a like number of Latin prepositions and their application to language development, and to philological research.

The question is, whether the culture of corn roots and the investigation of corn-root insects and diseases or the culture of clover roots, with their millions of symbiotic bacteria and their wonderful power to transform much of the impoverished lands of that part of Illinois whose name is "Egypt," and much of the exhausted and abandoned lands of India, whose fame is famine, into fruitful and valuable lands, may serve as well for the development of the mind and for the advancement of education and civilization, as the culture of Greek roots, and Sanskrit roots, and Hindu roots, from which we learn that the people of India, of whom only one man in ten, and only one woman in a hundred, are able to read and write—from which we learn that these people are our own cousins; that many words still live in India and in America that have witnessed the first separation of the northern and the southern Aryans; and, in the words of Max Müller:

> These are witnesses not to be shaken by any cross examination. The terms of God, for house, for father, mother, son, daughter, for dog and cow, for heart and tears, for axe and tree, identical in all the Indo-European idioms, are like the watchwords of soldiers. We challenge the seeming stranger, and, whether he answer with the lips of a Greek, a German or an (East) Indian, we recognize him as one of ourselves. There was a time when the ancestors of the Celts, the Germans, the Slavonians, the Greeks and Italians, the Persians and Hindus, were living together beneath the same roof.

Why has the southern Aryan civilization developed but one school for every five villages, while the northern Aryan, save in Russia, opens to every child the door of the school which leads on, for those who will, to the college and university? Why? Because only a prosperous nation can afford the trained intelligence or education of its people.

Education in America is not the cause, but the product, of our prosperity; and, thus far, the prosperity of this nation is due to our conquest of the former inhabitants and to the consequent acquisition of the great natural resources of this country,

[1] One of the papers presented February 19, 1910, before the Illinois State Academy of Science in the symposium on the "Relation of Pure and Applied Science."

including, primarily, vast areas of rich virgin soil; and, secondarily, immense supplies of timber, coal, and iron.

American prosperity has done more than educate Americans; it has educated western Europe, first of all by relieving the over-crowded condition of those impoverished lands, and subsequently by making large direct contributions to European prosperity, in supplying cheap food and fertilizer and a good market for European products, manufactured in large part from the low-priced raw materials secured from this and other new countries.

Applied science has already made some contributions to American education and civilization, and so far as its use in the schoolroom is concerned, applied science, as an educative agency, is not exceeded in value by any other instrumentality. Its very general acceptance by teachers and students in our leading educational institutions does not prove its value, but does prove that its value is being appreciated; and I need not remind you that pure science is the foundation of applied science.

While education has not been in any sense the prime cause of our national prosperity, the future prosperity of America depends absolutely upon the application of science and education to industry. For three full centuries America has lived upon the spoils of conquest and inherited wealth and resources, and for three full centuries America has wasted her substance or scattered it abroad. But even among nations there is a limit to inherited wealth. The land which flowed with milk and honey is now almost a barren waste, supporting only wandering bands of marauding Arabs and villages of beggars.

Truly the two most characteristic attributes of rich young America are wastefulness and bigotry. Other nations have risen to positions of world power and influence and fallen again to poverty, ignorance and insignificance. Thus far American history has been in large part a repetition of the history of nations long since gone to decay.

Following the rise and fall of the great empires of Babylon, of Carthaginia and of Greece, the Roman Empire also rose and fell. From what cause? Some tell us that the fall of those great empires was due to the development of pride and immorality among their peoples, forgetting the fact that civilization tends rather toward peace and security, and that universal education depends and must depend upon material prosperity. Poverty is at once helpless and soon ignorant.

History tells us that Roman agriculture declined until a bushel of seed brought only four bushels in the harvest—declined until the high civilization of the Mediterranean countries passed into the dark ages which covered the face of the earth for a thousand years, until the discovery of a new world brought new supplies of food, renewed prosperity, and new life and light to western Europe; but the dark ages still exist for most of our own Aryan race in Russia and in India, where, as an average, day by day, and year by year, more people are hungry than live in the United States, where the average wage of a man is fifty cents a month, where famine rages always, and where the price of wheat sometimes rises to a point where six months' wages of a working man are required to buy one bushel. This is the condition where the absolute needs of the population exceed the food supply; and just so sure as the intelligent and influential men and women of America continue to ignore the material foundation upon which national prosperity depends, just so sure will future dark ages blot out American civilization.

That vast areas of land that were once

cultivated with profit in the original thirteen states are now agriculturally abandoned is common knowledge; that much of the land in all adjoining states is in the process of abandonment is known to many; and that the common lands in the great agricultural regions in central United States are even now in process of the most rapid soil depletion ever witnessed is known to all who possess the facts.

Already the question of food has begun to exert pressure in this country. Already the masses, the common people, the "ninety per cent.," must consider a reduction in their standard of living. Poverty and degeneracy are even now making such demands upon the revenues of the state that education and research already suffer from inadequate support; and the only hope of the future lies in the application of science and education to the control of industry and to the control of population; and let us never forget that agriculture is the basis of all industry, and that the fertility of the soil is the absolute support of every form of agriculture.

Some will say that the economic conditions have been such that the depletion of the lands of the eastern states has been a necessary sequence, and that the restoration of those lands will now follow as an economic necessity. I beg of you, do not accept any such theoretical deductions. If systems of permanent progressive agriculture are ever to be adopted anywhere in this country, it must be done while the landowners are still prosperous. Some investment is necessary for the restoration of depleted soil, and poverty makes no investments. Much of the abandoned lands of America are far past the point of possible self-redemption. They were depleted not because of any economic necessity, but because of ignorance, and the fault lies not with the farmers and land owners, but with the educators who even until the present generation have taught almost everything except the application of science to agriculture. The fault lies also with the statesmen who, as James J. Hill says, have "unduly assisted manufacture, commerce and other activities that center in cities, at the expense of the farm."

There was no need whatever that the cultivable farm lands of the eastern states should have been depleted. Lying at the door of our greatest markets, with the application of knowledge and with such encouragement as should have been given, those lands could easily have been preserved and even increased in fertility until their present value would have been not five dollars, but five hundred dollars an acre.

Even now are the young men of the United States putting ninety million dollars a year into Canadian farms. Why? Because they were not taught in the schools that by investing those millions in the application of science to agriculture they can remain in the United States and secure greater profit and also save our soils from depletion; yes, make our partially depleted lands even more productive than they ever were, and at the same time provide the food that will soon be required to feed our own children.

Why do we permit the annual exportation of more than a million tons of our best phosphate rock, for which we receive at the mines the paltry sum of five million dollars, carrying away from the United States an amount of the only element of plant food we shall ever need to buy, that, if retained in this country and applied to our own soils, would be worth not five million, but a thousand million dollars, for the production of food for the oncoming generation of Americans?

Why this exportation? Because the present owners of American land learned only the art of agriculture and were never taught the science of farming; and it may well be repeated that the responsibility rests not with the farmer, but with the statesman and the educator.

Note well the following facts:

During the past dozen years the average acreage in corn and wheat in the United States has been increased by 30 per cent.; but notwithstanding the enormous increased production thus made possible, we have been obliged to decrease our average exportation of corn and wheat from nearly one fourth to only one tenth of our total production; and at the same time the average price of these great basic food materials has increased by 52 per cent., corresponding approximately to the increase in the value of land in the great corn and wheat states, and to the consequent and inevitable general advance in the cost of living.

You will remember that the population of the United States has increased 100 per cent. in thirty years, and without doubt will number more than 90 millions in 1910; but, notwithstanding the great areas of rich virgin lands brought under cultivation in the west and northwest, and notwithstanding the abandonment of great areas of depleted soil in the east and southeast, during the last forty years the average yield per acre of these two great grain crops has not even been maintained according to the twenty-year averages of the crop statistics of the federal government for the forty years from 1866 to 1905, as reported in the 1908 year book of the United States Department of Agriculture.

Shorter periods might be selected which would give apparent indications of a different tendency, but less than twenty-year averages are not trustworthy for ascertaining the average yield per acre; and these two twenty-year averages show that the decrease in yield of corn has exceeded the slight increase in yield of wheat, much of which, it should be remembered, is now grown on land less than forty years under cultivation. And this statement holds not only for the entire United States, but also for the great north central grain belt, including Ohio, Kansas, North Dakota and the ten other states lying within that triangle.

Thus, in this boasted "granary of the world," the records of forty years show that the average yield of wheat has increased one half bushel per acre, while the average yield of corn has decreased two bushels per acre.

Why should the average yield of corn in the United States be only 25 bushels per acre and the average yield in Illinois be only 35 bushels per acre, when the average yield upon the farm of the University of Illinois, on normal soil under practical, profitable and permanent scientific systems of farming, is 87 bushels per acre?

There are at least four factors involved in the solution of the problem of maintaining prosperity, civilization and universal education in this country. These four factors may be classified as exploitational, scientific, legal and economic.

1. Further exploitation of our remaining virgin soils, as by irrigation and drainage, neither of which is of large significance in comparison with the magnitude of our present agricultural development.

2. The restoration, by practical scientific methods, of depleted lands and large increase in productive power of practically all lands now under cultivation. This is the only great positive factor.

3. The legal control of increase in population by the enactment and enforcement of suitable laws.

4. The reduction in the standard of living, by extending the tendency already enforced to some extent, as in the gradual withdrawal of meat and other valuable food products from the daily diet, and adopting such standards as are common in China and Japan, where beef, butter and milk are practically unknown.

The greatest study of mankind is not man, but the application of principles upon which depends the preservation of man's prosperity and civilization; and this study must not only include the application of science to raise high the limitations of the production from the soil of necessary food supplies, but it must also include the application of sense in placing some just and necessary limitations upon the reproduction of the least fit of human kind.

CYRIL G. HOPKINS
UNIVERSITY OF ILLINOIS

ATTENDANCE OF STUDENTS AT FOREIGN UNIVERSITIES

The following table, which I have recently compiled, may be of interest to your readers.

These figures of attendance were furnished to the U. S. Commissioner of Education by the editor of *Minerva,* were printed by him in his annual report for 1908 (not summarized as here, but in detail for each institution, country by country), and are probably as complete as any which could be readily found or compiled. That these totals understate, rather than overstate, the attendance in some of the countries which have not taken the pains to prepare complete official statistics is highly probable; thus in SCIENCE, September 24, 1909, there are given figures quoted from Professor B. Menschutkin, writing in *Nature,* which claim a total attendance of students in the higher educational institutions of Russia for the years of 1908 and 1909, of 76,900, with the surmise of possibly 20,000 more in private higher colleges in different towns—a total of 96,900 as opposed to 54,208 given in the table for the year 1907 as a total of the figures furnished by the editor of *Minerva.*

I have not *Nature* at hand, but as quoted in SCIENCE Professor Menschutkin fails to state from what source his figures were drawn and I have therefore not been able to check them and, consequently, have not felt free to use them in this table in place of those having the sanction of "official" source. My own belief is that the total for Norway is considerably less than it should be if it represented complete results, but I have not, after due search, been able to find official supplementary figures. The same may be true in the case of some other countries, but the table is significant enough as it stands in the showing it makes of the widespread interest and participation in higher education.

Country	Population	Number of Students in Higher Educational Institutions, 1906–7	Population per Student
United States	83,941,510 (Est. 1906)	283,395[1]	296
		212,956[2]	394
Switzerland	3,463,609 (Cen. 1905)	10,511	330
France	39,252,267 (Cen. 1906)	50,935	771
Denmark	2,605,268 (Cen. 1906)	3,363	775
Germany	60,641,278 (Cen. 1905)	73,020[3]	830
Austria-Hungary	46,973,359 (Est. 1906)	51,691	909
Greece	2,631,952 (Cen. 1907)	2,836	928
Italy	33,640,710 (Est. 1907)	33,174	1,014
Belgium	7,238,622 (Est. 1906)	7,139	1,014
Netherlands	5,672,237 (Cen. 1906)	5,435	1,044
United Kingdom	44,100,231 (Est. 1906)	41,305[4]	1,068
Spain	18,831,574 (Cen. 1900)	15,642	1,204
Roumania	6,585,534 (Est. 1907)	5,336	1,234
Sweden	5,337,055 (Cen. 1906)	4,032	1,324
Portugal	5,423,132 (Cen. 1900)	3,923	1,382
Norway	2,321,088 (Est. 1906)	1,500	1,547
Servia	2,676,989 (Est. 1904)	1,022	2,619
Russian Empire	149,299,300 (Est. 1906)	54,208	2,754
Bulgaria	4.035.620 (Cen. 1905)	1,324	3,048

Population from "Statesman's Year Book," 1908. Number of Students from "Report of U. S. Commissioner of Education," 1908, Vol. I.

GUIDO H. MARX

ELECTIONS TO THE AMERICAN PHILOSOPHICAL SOCIETY

AT the annual elections for members of the American Philosophical Society on April 23, fifteen residents of the United States and five

[1] Including normal schools.
[2] Excluding normal schools.
[3] Including hearers.
[4] Excluding 22,159 "evening students."

foreign residents were, according to the custom of the society, elected to membership, from among the forty-nine nominations. The members elected, together with the credentials presented by their proposers, are as follows:

Simeon Eben Baldwin, LL.D., New Haven. Professor of Constitutional and Private International Law in Yale University. Justice of the Supreme Court of Errors of Connecticut, 1893–1906, and Chief Justice, 1906–1910. President of American Bar Association, 1890; of American Social Science Association, 1897; of International Law Association, 1899–1901; of American Historical Association, 1905; of Association of American Law Schools, 1902. Author of "Baldwin's Connecticut Digest"; "Cases of Railroad Law"; "Modern Political Institutions"; "American Railroad Law"; "American Judiciary."

Francis G. Benedict, Ph.D., Boston. Director of the Nutrition Laboratory of the Carnegie Institution; Professor of Chemistry at Wesleyan University, 1896–1905; Physiological Chemist of Nutrition Investigations of United States Department of Agriculture, 1895–1907. Author of extensive experimental investigations in nutrition, based largely on studies with the respiration calorimeter and of numerous contributions to organic and physiologic chemistry. Member of the American Chemical Society, American Physiological Society, Deutsche Chemische Gesellschaft, etc.

Charles Francis Brush, Ph.D., LL.D., Cleveland, Ohio. Electrical Engineer. Designed the Brush Series of Arc Lighting Dynamo, and the Series Arc Lighting System. Has for many years devoted himself to scientific research. Decorated by the French Government in 1881 for achievements in electrical science. Received the Rumford medal of the American Academy of Arts and Sciences in 1899.

Douglas Houghton Campbell, Ph.D., Palo Alto, Cal. Professor of Botany at Leland Stanford University. The most prominent student of the structure and development of the higher cryptogams in this country, and has an expert knowledge of the embryology of higher plants. Author of valuable books and papers on the comparative morphology of plants, evolution of plants, structure and development of the mosses and ferns, and embryology of the simpler angiosperms.

William Ernest Castle, Ph.D., Payson Park, Belmont, Mass. Professor of Zoology at Harvard University; student of heredity by experimental methods. Author of works of importance on heredity of sex, inheritance of characteristics in rabbits, mice and guinea pigs.

George Byron Gordon, Philadelphia. Assistant Professor of Anthropology and Director of the Museum of Archeology of the University of Pennsylvania. Author of various papers on American Archeology in the publications of the Peabody Museum, and of the Museum of Archeology of the University of Pennsylvania.

David Jayne Hill, LL.D., American Embassy, Berlin. Diplomatist, jurist and author. President of Bucknell University from 1879–1888, and of Rochester University from 1888–1896; Assistant Secretary of State, 1898–1903; United States Minister to the Netherlands, 1905–1907; Ambassador to Germany since 1907; Member of the Permanent Administrative Council of The Hague Tribunal. Author of a "Life of Washington Irving," "Elements of Rhetoric," "Life and Works of Grotius," "A History of Diplomacy."

Harry Clary Jones, Ph.D., Baltimore. Professor of Physical Chemistry in Johns Hopkins University. Brilliant investigator of problems connected with physical chemistry. Author of several works on that subject and contributor to American, German and French scientific journals on chemical and physical phenomena.

Leo Loeb, M.D., Philadelphia. Assistant Professor of Experimental Pathology in University of Pennsylvania. Research worker in animal pathology and general pathology. Author of papers on Regeneration and Transplantation of Tissues; Etiology and Growth of Tumors; Coagulation of the Blood and Thrombosis; Venom of Heloderma, etc. One of the Board of Editors of *Folia Hæmatologica;* Collaborator of the *Biochemisches Centralblatt; Zeitschrift für Krebsforschung;* and *Jahresbericht über Immunitätsforschung.*

James McCrea, Ardmore, Pa. Civil Engineer; President of the Pennsylvania Railroad.

Richard Cockburn Maclaurin, F.R.S., LL.D. (Cantab.), Boston, Mass. Formerly Professor of Mathematical Physics in University of Wellington, New Zealand, and of Applied Mathematics in Columbia University, New York. President of the Massachusetts Institute of Technology. Author of many scientific articles of high value. Distinguished for investigations in mathematical physics, especially physical optics, published chiefly in Proceedings of Royal Society.

Benjamin O. Peirce, Ph.D., Cambridge, Mass. Professor of Mathematics and Natural Philosophy in Harvard University. Eminent authority on

mathematical physics and magnetism. Author of "Theory of the Newtonian Potential Function"; "Experiments in Magnetism," and of numerous scientific papers on physics and mathematics. Fellow of the American Academy of Arts and Sciences; Member of the National Academy of Sciences; American Mathematical Society; American Physical Society; Astronomical, and Astrophysical Societies of America, etc.

Harry Fielding Reid, Ph.D., Baltimore. Professor of Geological Physics in Johns Hopkins University, Baltimore. Special agent in charge of earthquake records in U. S. Geological Survey. Professor of Mathematics (1886–89) and of Physics (1889–94) in Case School of Applied Science, Cleveland, Ohio. Author of "Reports on the Highways of Maryland," and of article on glaciers.

James Ford Rhodes, LL.D., Boston, Mass. Historian. Author of "History of the United States from the Compromise of 1850," in seven volumes (1850–77). Recipient of the Loubet Prize of the Berlin Academy of Sciences.

Owen Willams Richardson, M.A. (Cantab.), D.Sc. (Lond.), Princeton, N. J. Professor of Physics in Princeton University. Has published since 1901 important papers on the radioactive discharges from hot bodies. These researches have recently led to the experimental verification of Maxwell's law of distribution, and are still in active progress. His papers have appeared in the Philosophical Transactions and in the London, Edinburgh and Dublin Philosophical Magazine.

FOREIGN RESIDENTS

Adolf von Baeyer, Ph.D., M.D., F.R.S., Münich. Professor of Chemistry in University of Münich since 1875. Fellow of the Royal Society; Member of the National Academy of Sciences, and of the Academies of Berlin, St. Petersburg, Vienna and Rome, and of the Institute of France. Distinguished for his investigations in the field of organic chemistry. Recipient of the Nobel prize in chemistry in 1905 and was awarded the Davy Medal by the Royal Society in 1881 for his researches on indigo.

Madame S. Curie, Paris. Chemist; Discoverer of Polonium, Radium, etc.

Sir David Gill, K.C.B., Sc.D., LL.D., F.R.S., London. H. M. Astronomer at Cape of Good Hope, 1879–1907. President of the Royal Astronomical Society; Past-president of the British Association for the Advancement of Science; Member of the Academies of St. Petersburg, Berlin, Rome, of the Institute of France and of the National Academy of Sciences. In 1877 proposed and carried out an expedition to Ascension Island to determine the solar parallax by observations of Mars. Author of report of this expedition; of Heliometer Determinations of Stellar Parallax in Southern Hemisphere; Determination of the Solar Parallax and Mass of the Moon from Heliometer Observations of Victoria and Sappho; Gold Medallist of the National Academy of Sciences; of the Astronomical Society of the Pacific; and of the Royal Society.

Edward Meyer, Ph.D., LL.D., Berlin. Professor of Ancient History in the University of Berlin. Leading authority on ancient oriental history. Author of "Geschichte des Altertums"; "Forschungen zu Alter Geschichte"; "Die Israeliten und ihre Nachbarstämme"; and of numerous papers and monographs. German Exchange Professor at Harvard University (1909–10).

Charles Emile Picard, Paris. Vice-president of Academy of Sciences of Paris; Professor of Analyse Supérieure in the University of Paris, and of General Mechanics at l'Ecole Centrale des Arts et Manufactures. Member of the Academies of Berlin, St. Petersburg, Rome, Copenhagen, Turin, Bologna, Boston and Washington; Member of the Royal Societies of Göttingen, Upsala and Helsingfors. Author of Traité d'Analyse; Théorie des functions Algébriques de deux Variables and of numerous memoirs upon mathematics.

THE GEORGE WASHINGTON MEMORIAL BUILDING

The council of the American Association for the Advancement of Science, at its meeting in Boston in December, gave its approval to the general plan of the George Washington Memorial Association to erect in the city of Washington a building to serve as a home and gathering place for national, patriotic, scientific, educational, literary and art organizations, including the American Association for the Advancement of Science, and authorized the appointment of a committee of five to assist in the effort.

President Michelson appointed as this committee Dr. C. D. Walcott, secretary of the Smithsonian Institution, Dr. Ira Remsen, president of Johns Hopkins University, Dr. William H. Welch, of the Rockefeller Institute, Dr. George M. Kober, of the George-

town University, and Dr. L. O. Howard, permanent secretary of the American Association for the Advancement of Science.

In late March, this committee sent out an appeal to members urging contributions to aid in the erection of the memorial building. The committee reports that to April 19, contributions had been received to the amount of $4,050. The committee still hopes to receive a considerably larger sum and the general committee of the George Washington Memorial Association is much pleased with the generous and immediate response from the members of the American Association.

SCIENTIFIC NOTES AND NEWS

Members of the National Academy of Sciences have been elected as follows: Forest Ray Moulton, assistant professor of astronomy in the University of Chicago; William Albert Noyes, professor of chemistry in the University of Illinois; Thomas Burr Osborne, research chemist in the Connecticut Agricultural Experiment Station; Charles Schuchert, professor of paleontology in Yale University; Douglas Houghton Campbell, professor of botany in Stanford University; Jacques Loeb, professor of physiology in the University of California, who will become head of a department in the Rockefeller Institute for Medical Research, and John Dewey, professor of philosophy in Columbia University. Dr. George E. Hale, director of the Mount Wilson Solar Observatory of the Carnegie Institution, has been elected foreign secretary of the academy, to succeed the late Mr. Alexander Agassiz. The Draper medal has been conferred on Dr. C. G. Abbot, director of the Astrophysical Observatory of the Smithsonian Institution.

Dr. John Trowbridge, Rumford professor and lecturer on the application of science to the useful arts, at Harvard University, and director of the Jefferson Physical Laboratory, will retire from active service at the close of the present academic year.

Dr. Leo Loeb has resigned his position as assistant professor of experimental pathology in the University of Pennsylvania and will take up the directorship of the pathological department of the St. Louis Skin and Cancer Hospital on September 1 of the present year. Dr. Moyer S. Fleisher, of Philadelphia, accompanies him as one of his assistants.

Professor Robert Koch, who has been seriously ill with pneumonia at Berlin, is now making favorable progress.

Dr. Bashford Dean, Columbia University, has lately received a silver cup from the Emperor of Japan in recognition of his services to Japanese zoology.

The Linnean Society will award the Linnean gold medal to Professor Georg Ossian Sars, professor of zoology in the University of Christiania.

Professor F. W. Putnam, of Harvard University, has been elected a corresponding member of the Societá Romana di Anthropologia, of Rome.

M. Charles Lallemand has been elected a member of the Paris Academy of Sciences in the section of geography and navigation in the place of the late Bouquet de la Grye.

Sir Ernest Shackleton, the Antarctic explorer, was presented with a gold medal by the Geographical Society of Pennsylvania at a dinner given in his honor at Philadelphia on April 22. Rear Admiral George Melville and Amos Bonsall, a survivor of the Kane Arctic expedition, were among the speakers.

McGill University will confer on Professor Louis A. Herdt, head of the department of electrical engineering, the degree of doctor of science.

Dr. M. P. Ravenel, head of the department of bacteriology of the University of Wisconsin, and of the State Hygienic Laboratory, is a member of the American committee to report at the Second International Congress of Alimentary Hygiene at Brussels, Belgium, October 4, on bacteriological aspects of the hygiene of nutrition.

The Academy of Natural Sciences of Philadelphia has appointed Professor J. C. Arthur, of Purdue University, a delegate to represent it at the third international Botanical Congress.

Wellesley College has appointed Professor C. B. Thompson delegate to the international zoological congress at Graz. Miss Thompson will sail for Antwerp on June 25, and will spend the greater part of the summer in Austria.

Dr. James R. Angell, professor of psychology in the University of Chicago, has left this country for Great Britain.

Dr. W. Cramer, of the physiological department of the University of Edinburgh, is visiting some of the American universities.

Memorial services were held in Sage chapel at Cornell on April 24 for Ross G. Marvin, who lost his life on the Peary expedition. Commander Peary delivered the memorial address, dedicating a tablet which has been erected in the chapel to Professor Marvin's memory. President Jacob Gould Schurman read a biographical sketch, written by Professor O. M. Leland, a member of the faculty of the College of Civil Engineering, to which Professor Marvin belonged.

The death is announced of M. Charlois, of the Nice Observatory, known especially for his work on the minor planets.

Mr. C. Bird, headmaster of the Rochester Mathematical School and the author of textbooks on geography and geology, died on April 11, aged sixty-seven years.

The senate committee has given its approval to a proposed amendment to the sundry civil bill providing for the establishment of a seismological laboratory in connection with the Smithsonian Institution. The proposed annual appropriation is $20,000.

A joint meeting of the American Society of Mechanical Engineers with the Institution of Mechanical Engineers will be held this summer in Birmingham and London, beginning on July 26.

We learn from *Nature* that in connection with the aviation week to be held at Verona in the first fortnight of May, it is proposed to organize a first International Congress on Aerial Locomotion. On the scientific side the movement has received the support of Professors Angelo Battelli (Pisa), Giovanni Celoria (Brera Observatory), Giuseppe Colombo (Milan), Count Almerigo di Schio, Dr. Enrico Forlanini, Professor Luigi Palazzo, Professor Righi (Bologna), Professor Vito Volterra (Rome).

A preliminary program has been issued for this year's meeting of the British Association, which is to take place at Sheffield on August 31 and following days. The president, the Rev. Professor T. G. Bonney, will have the assistance of representatives of the municipal, educational, ecclesiastical and commercial activities of the city, who have been appointed as vice-presidents for the meeting, headed by the Lord Mayor, the Rt. Hon. Earl Fitzwilliam. To the list of sections, whose presidents have already been announced, there has been added, as in previous years, a sub-section of agriculture, which this year will be formed under the section of chemistry, with Mr. A. D. Hall, F.R.S., as chairman. The conference of Delegates of Corresponding Societies will assemble this year as usual, at Sheffield, during the meeting, and not in London, as last year, when the meeting was in Canada. Its chairman will be Dr. Tempest Anderson. The reception room and administrative offices during the meeting will be established in the Cutlers' Hall. It is centrally situated, and a great majority of the sectional meeting-rooms will be within a very short distance of it. The Victoria Hall will be the scene of the opening meeting on Wednesday evening, August 31, when Professor Bonney will deliver his inaugural address. In the same hall the first evening discourse will be delivered on the Friday evening by Professor William Stirling on "Types of Animal Movement," and the second on the Monday evening by Mr. D. G. Hogarth on "New Discoveries about the Hittites." Receptions are announced to be given by the lord mayor and by the university, and a number of garden parties will be arranged. The city itself and its vicinity offer a wide range of scientific interests, as for example to chemists and metallurgists, geologists, and students of economic and educational problems, while its close proximity to the Peak district, the "Duker-

ies" and other interesting localities affords many opportunities for relaxation.

Owing to the delay in the issuance of the second circular of the Eighth International Zoological Congress, at Graz, the president requests us to call the attention of the American members to the following points. Apparently all the state railways of Austria as well as the "Südbahn" will allow a very material reduction in the price of tickets, upon the exhibition of membership or participant's cards as soon as the Austrian frontier is crossed. It is therefore best for all to have these cards before entering Austria and prospective members should send their remittance (members 25 Kronen, participants 12 Kronen —a Krone is a little more than 20 cents) to the "account of the VIII. International Zoological Congress" at the Steiermärkische Escomptebank in Graz. All applications for accommodations should be addressed to the Præsidium des VIII. Internationalen Zoologenkongress, Universitätsplatz 2, Graz, Austria, and should specify the number of rooms, beds, price desired, the day, and where possible the hour of arrival in Graz. The hotel accommodations of the city are rather limited and it is probable that students' rooms will have to be used, this involving getting the meals in another place. It is expected that the English edition of the second circular will be issued about the first of May.

Graduate students in geology from the University of Wisconsin are spending the month of May in detailed mapping of the pre-Cambrian rocks of the Menominee iron-bearing district of Michigan. Professor C. K. Leith and Mr. W. J. Mead are in charge of the party. This work constitutes a regular course in geology at the University of Wisconsin.

The first meeting of New York state teachers of educational psychology was held at Ithaca, April 8 and 9, at the invitation of the Educational Department of Cornell University. Representatives of the college and normal schools of the state discussed the extent and form of instruction in the nervous system, and the place of experimental work, in the course in educational psychology. The latter discussion resulted in the formulation of the chief purposes for which experimental work might be introduced, and of the criteria for the selection of specific experiments. The discussion of experimental work was supplemented by an exhibition of the apparatus used for demonstration in the Cornell course in general psychology, of the drill and research equipment of the psychological laboratory, and of apparatus in the educational laboratory for the conduct of mental tests. By invitation, the evening meeting was held in the psychological laboratory, where the formal program was followed by an exposition by Professor Titchener of the contributions of the Cornell laboratory to structural psychology, with special reference to the experimental psychology of the thought-processes. A committee consisting of Professor G. M. Whipple, of Cornell (chairman), Professor George M. Forbes, of Rochester, Dr. W. Van Dyke Bingham, of Columbia, and Dr. Susan F. Chase, of the Buffalo Normal School, was appointed to arrange for a meeting next year.

Provision has been made for instruction and field work in botany, zoology and geography at the Illinois Biological Station recently established on Quiver Lake, an offset of the Illinois River one and a fourth miles above Havana in Mason County, Illinois. The students will have as the field of their observations, the banks of the Illinois River itself, a series of lakes, streams and bayous of the vicinity, and the bottoms, bluffs and uplands adjacent, which present a great variety of situations unusually rich in all plant and animal forms. All students will have the use of the Chautauqua grounds of the State Association of Epworth Leagues. Sleeping and dining rooms, laboratories and a lecture room are thus provided, ready for use. The grounds are on a forest-covered, somewhat sandy, elevated bank or bluff, bordering Quiver Lake, are lighted by electricity and are abundantly supplied with pure water. The session will begin June 20 and continue six weeks.

The New York Botanical Garden has arranged spring lectures to be delivered in the lecture hall of the museum building of the garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

April 30—"Spring Flowers," Dr. N. L. Britton.

May 7—"Collecting in Southern Mexico," Dr. W. A. Murrill.

May 14—"The Origin and Formation of Coal," Dr. Arthur Hollick.

May 21—"Water Lilies," Mr. George V. Nash.

May 28—"An Expedition to the Panama Canal Zone," Dr. M. A. Howe.

June 4—"Summer Flowers," Dr. N. L. Britton.

June 11—"The Rose and its History," Mr. George V. Nash.

June 18—"The Native Trees of the Hudson Valley," Mr. Norman Taylor.

June 25—"The Extinct Flora of New York City and Vicinity," Dr. Arthur Hollick.

July 2—"The Fungous Diseases of Shade Trees," Dr. W. A. Murrill.

The Third International Physiotherapeutic Congress was inaugurated by President Fallières in the courtyard of the School of Medicine at Paris, on March 29. The London *Times* states that a large number of members of the French government and the diplomatic corps in Paris, including the British and American ambassadors, were present at the ceremony. M. Fallières in his address declared that all questions relating to the public health were the intimate concern of every government. He spoke of the advance of medical science in having established the fact that some diseases which were the great scourges of humanity could no longer be regarded as "inevitable," and he ventured to look forward to the day when by the aid of medical science these diseases would be actually eliminated. He also felt that the medical profession was justified in its hope of a future population which would be better adapted physically for the struggle of modern life in the office and in the workshop.

UNIVERSITY AND EDUCATIONAL NEWS

Assemblyman Whitney's bill to establish a state school of sanitary science and public health at Cornell University, and to appropriate $10,000 toward its maintenance, has passed the New York assembly.

The mining engineering building of the University of Wisconsin, formerly the old heating plant, has been entirely rearranged for its new purposes, and is nearing completion, much of the equipment of modern mining machinery having already arrived, and the laboratories will soon be in readiness for research and instruction.

Dr. A. Stanley McKenzie, professor of physics at Dalhousie University, and previously at Bryn Mawr College, has accepted a chair of physics at the Stevens Institute of Technology.

Dr. Charles A. Kofoid, associate professor of histology and embryology in the University of California, has been appointed professor of zoology in that institution.

Mr. Henry Homan Jeffcott, head of the meteorology department of the British National Physical Laboratory, has been appointed to the chair of engineering in the Royal College of Science for Ireland.

DISCUSSION AND CORRESPONDENCE

THE PLANET MARS

To the Editor of Science: I should very much like to urge the importance of the suggestion made by Professor R. G. Aitken in the issue of Science for January 21, 1910, that Mr. Percival Lowell invite a committee of *recognized experts* in planetary observation, to go to Flagstaff and with him to observe the planet Mars (and if possible Venus and Mercury also).

I find here in South America just as keen an interest by the public in the real state of our knowledge as to Mars, as anywhere in the world, and am sure that no greater service could be rendered to astronomical science from the standpoint of the intelligent public, than to settle some of the many open questions relating to the surface markings of Mars.

As Professor Aitken points out, "doctors disagree" in this matter and to such an ex-

tent that the average man knows not what to believe, he sees so many contradictory statements, drawings and photographs.

It need hardly be pointed out that little real progress can be made in any branch of scientific work until the fundamental points are placed on a much more secure foundation than are many of the most important details regarding Mars.

It would seem that the best way of finally settling some of these matters would be, as suggested by Professor Aitken, to have them passed upon by a committee of experts of such well-recognized standing as to make their unanimous verdict final and acceptable to all scientific men.

Then, and not until then, will these questions of the surface markings of Mars be upon a dependable basis.

It is also pertinent to point out the saving of time which will result in many ways and to many people by having a sure foundation in this matter.

The financing of such a project should not be at all difficult considering the general interest which attaches to Mars.

C. D. Perrine

KIRCHER AND THE GERM THEORY OF DISEASE

It would appear from Dr. Garrison's article on "Fracastorius, Athanasius Kircher and the Germ Theory of Disease,"[1] that I am in the usual plight of one who attempts to fix credit for the early suggestion of a scientific theory. Apparently there is always to be found some one who had thought it all out long in advance of—the next man. But though I have no desire to play the rôle of special pleader for Athanasius Kircher, it is only fair to point out that Dr. Garrison does this early investigator an injustice when he says that "Neither Kircher nor Leeuwenhoek could have seen bacteria of any kind with the lenses at their command. . . . His [Kircher's] glass or microscope was only 32 power at best."

Aside from Kircher's apparently loose statement that one of his microscopes showed objects "a thousand times larger," we have no direct data regarding the magnifying power of his lenses. We do know that the simple microscopes of his and Leeuwenhoek's time possessed great magnifying power and that by their use many structures were studied which at present we should not think of examining without a compound microscope. We know, too, that of the several microscopes described or figured by Kircher, one type was fully comparable to those of Leeuwenhoek and, fortunately, concerning the latter we have very full and definite information. One of the Leeuwenhoek microscopes still extant and described by Harting, had a magnifying power of 67 diameters. The twenty-six microscopes presented to the Royal Society of London, by Leeuwenhoek, varied in magnifying power from 40 to 160 diameters. The maximum power of those known is possessed by one still preserved in the Museum at Utrecht, which magnifies 270 diameters.

In the face of these facts and Leeuwenhoek's detailed description of, for instance, the organisms found in scrapings from the teeth, it hardly needs the additional evidence of his illustrations to prove that this worker really saw bacteria. No one believes that Kircher anticipated by some two hundred and fifty years Yersin's and Kitasato's discovery of the bacillus in the blood of plague patients, but I still believe that "There is no doubt that long before Leeuwenhoek's discovery, Kircher had seen the larger species of bacteria" in putrid broth, milk and the like. Imperfect and faulty as his observations must have been, he had definite observation as a basis for his theory of the animate nature of contagion. Certainly, his conception of the rôle of flies in the transmission of disease marked an advance over the theory of Mercurialis.

William A. Riley

[1] Science, April 1.

KAHLENBERG'S CHEMISTRY

To the Editor of Science: Inasmuch as possibly a large majority of teachers of first-year college students will agree with Dr. Hopkins in his criticism[1] of Lewis's review of

[1] Science, N. S., XXXI., p. 539.

Kahlenberg's "Chemistry," I feel impelled, as one who has had considerable experience in teaching first-year students, to express my hearty agreement with the points made by Dr. Lewis. Let me say, to begin with, that it is not improbable the teacher who deals with the finished product of the one who has done the "first-year teaching" is better capable of judging the success of that teaching than the first-year teacher himself. I have been inclined to judge my own work by the way my students have been able to handle advanced work, rather than by their success with the first-year's work itself. I therefore believe the teacher of advanced students is the most competent critic of elementary work, and that Dr. Lewis is in the best possible position to judge of methods of laying foundations in chemistry.

The more important question at issue, however, which is squarely met by author, reviewer and critic, is whether we shall present the conceptions of modern physical chemistry to first-year students. And it should be remembered that this is not the question of the truth of a theory of electrolytic dissociation, but whether such conceptions as electrolytic dissociation, equilibrium and its disturbance, mass-action, phase-rule and others, which have furnished at least the best working hypotheses for the superstructure of modern chemistry, not merely theoretical, but industrial, shall be *used as fundamental conceptions,* for the first-year, second-year and every other year students; or shall be simply introduced in one or two chapters, apart from all the rest of the subject, as in Kahlenberg's book; or perhaps not mentioned at all in elementary chemistry, being left for some future time, should the student conclude to further pursue the branch. The two chapters in Kahlenberg's book which take up these conceptions might be absolutely omitted without injury to the rest of the book, as far as anything in the rest depends upon these two chapters. Many other older chemistries have been "brought down to date" by adding or inserting new chapters on these so-called modern conceptions. Is it not a little as if one were to modernize a medieval work on astronomy by adding a chapter on the work of Copernicus? Is it not a rather sad commentary on the chemical teaching of to-day when a professor in one of our leading and progressive colleges pleads for the "chemistry of a generation or more ago"? With no intent at irreverence, I can not refrain from quoting the lines that come to my mind from the old hymn,

> 'Twas good enough for father,
> 'Twas good enough for mother,
> 'Tis good enough for me.

Seriously, Kahlenberg's book represents probably the high-water mark of the older chemistry, and especially in presenting "just what the beginner wants to know in the way he wants to have it presented," but is it the neophyte who should be consulted regarding what he is to be taught? In my own case it has been far from an easy task to assimilate the fundamental conceptions of modern chemistry, and I do not desire that any student who goes out from my class-room shall be under the necessity of a complete mental revolution should he pursue the subject farther. It is better, even for the beginner, to study a smaller number of reactions as illustrative of fundamental laws than to make himself master of the great mass of facts of descriptive chemistry with which many of our text-books are filled. Elementary science seems ever to be the last to be influenced by great discoveries and generalizations. Only within the last decade or so have the elementary text-books on the biological sciences been appreciably influenced by the work of Darwin, so we need not be surprised if we find little evidence, even in many of our college text-books of chemistry, of the revolutions in chemical thought wrought by such men as Arrhenius, and Guldberg and Waage, and Mendeleeff, and Gibbs, and others, whose work has been before the world of chemistry for more than a quarter of a century.

Jas. Lewis Howe

Washington and Lee University

April 12, 1910

SCIENTIFIC BOOKS

MAGNETIC WORK OF THE BRITISH NATIONAL ANTARCTIC EXPEDITION OF 1901–4

Thus far three volumes of results in geophysics have been published by the Royal Society of the fruitful Antarctic expedition under the command of Commander R. F. Scott, R.N.: Meteorology (Part I., Observations at Winter Quarters and on Sledge Journeys, with discussions by various authors); Physical Observations (tidal, gravity, seismic, auroral and ocean magnetic observations), and just recently the volume "Magnetic Observations." We shall confine our attention to the magnetic work and especially to the last volume.

In the Report on the "Physical Observations," Commander L. W. P. Chetwynd, R.N., superintendent of the Compass Department of the British Admiralty, published and discussed the results of the magnetic observations made on board the *Discovery* during her cruise, as also those obtained on land. From the various sledge journeys, he deduced for the position of the south magnetic pole in 1903, as derived from the magnetic declination results, 72° 50′ S. and 156° 20′ E.; from the observations for magnetic dip, 72° 52′ S., 156° 30′ E., hence, average position 72° 51′ S., 156° 25′ E. While these two positions agree closely, it must be stated that neither depends upon observations made at or in the vicinity of the south magnetic pole, but upon more or less complete observations some distance away. The same is to be said of the position determined by the highly successful Shackleton expedition in the beginning of 1909, viz., 72° 25′ S. and 155° 16′ E.—forty miles distant of the 1903 position; the observer (Douglas Mawson) had not quite observed a dip of 90°. Were it sufficiently important, much more elaborate observations would be required than any made by the expeditions thus far; it is, accordingly, not possible to say whether the difference between the positions for the two expeditions actually represents the secular change between 1903 and 1909.

The *Discovery* being not strictly a non-magnetic vessel, the reduction of the magnetic observations on board must have presented at times difficulties. Only results for declination and dip are published—no force observations being given, though the instrumental appliances admitted also of such work.

Auroral observations were taken chiefly by the officer of the watch whenever there were displays, the physicist and chief magnetic observer, Mr. L. C. Bernacchi, supplementing the observations on special occasions. There are worked out diurnal and monthly periodic variations, change of direction of display during simultaneous appearances with aurora borealis, sun-spots and magnetic disturbances.

The volume on "Magnetic Observations" is devoted to a discussion by the superintendent of the Kew Observatory, viz., Dr. C. Chree, F.R.S., of the magnetic observatory observations made at the *Discovery's* "Winter Quarters," May, 1902, to January, 1904, in McMurdo Sound, latitude 77° 50′.8 S. and longitude 166° 44′.8 E. The magnetograph was of the German (Eschenhagen) portable type, the absolute instruments consisting of Kew pattern magnetometers and Dover dip circles. An entirely satisfactory site for the observatory could not be obtained because of the prevalence of local magnetic disturbances due to the basic volcanic rocks consisting particularly of basalt, containing grains of magnetite; observations for standardization purposes were accordingly made out on the ice over the deep sea.

The arduous duties of observer-in-charge were performed by Mr. Bernacchi, who also assisted Dr. Chree in the reductions and discussions of the data and preparation of the results for publication. There are added at the end of the volume various reproductions of the magnetograms of special interest not only as obtained by the *Discovery's* observatory, but also at the cooperating stations: Kew, Falmouth, Mauritius, Colaba and Christchurch.

In addition to the usual tables of hourly values of the magnetic elements, of the daily, the annual and of the secular variations, and results of related analyses, Chree opportunely devotes considerable space to a discussion of magnetic disturbances of various types. In

Appendix B he furthermore makes an examination of Antarctic disturbances from October, 1902, to March, 1903, simultaneous with those discussed by Professor Kr. Birkeland in Vol. I. of "The Norwegian Aurora Polaris Expedition 1902–3." While he finds correspondences, his examination also discloses certain disagreements from the effects predicted by Birkeland, thus showing the directions in which the latter's theory requires amplification.

It is a pity that a work of such importance as the volume before us should not be better indexed or at least better arranged so that one could readily turn to any desired topic. A more liberal introduction of subsections, subdivisions, etc., would have been helpful. In the mathematical analysis it might have been better also to have followed a notation now commonly in use.

L. A. Bauer

Traité de Géographie Physique. Par E. de Martonne. Paris, Armand Colin. 1909.

The present book is divided into five main parts: Notions générales, Climat, Hydrographie, Relief du Sol and Biogéographie. The reviewer does not propose to discuss the whole voluminous work, but restricts himself to the last part, the biogeographical, and a special chapter (chapter VIII.) of the fourth, namely, that on paleogeography.

A general treatise on biogeography is a hazardous undertaking at the present time; the science of the geographical distribution of the life upon the earth has undergone, during the last two decennia, such a revolution, and is still progressing at such a rapid rate, with much to be yet investigated, that we can not expect to be able to obtain a general view of the present state of our knowledge, which could be embodied as something final in a text-book.

M. de Martonne has fully realized this fact, and has avoided certain difficulties with great skill. In fact, he does not give a complete treatise of the science of biogeography according to the pattern, as laid down, for instance, by Wallace, and his book is by no means a compendium of distributional facts brought into a more or less satisfactory scheme; instead of this, he gives the general principles and laws, which govern the distribution of organisms, drawing from these the inferences with regard to the different groups of the latter, and illustrating them by selected examples.

Thus his treatment of biogeography is chiefly an account of the relations of the organic world to the physical conditions prevailing upon the earth, and might be called a general "Ecology." Three of the chapters (I., II. and IV.) are principally devoted to this side. For the rest, he discusses the distribution of plants and animals from this standpoint, dividing them into ecological classes, for which he gives the distribution upon the earth. He avoids by this, for instance by treating the different marine and terrestrial groups of animals separately, the difficulty of the association of creatures with different "habitats" into one scheme, which was the chief stumbling block of the older zoogeographers.

A very good illustration of the consequences of the author's method is seen in the map he gives for the distribution of the continental faunas (Fig. 390, on p. 852). This map differs greatly from the usual maps given for the distribution of land animals, but it is very well to keep in mind that it is not intended to represent the actual distribution of any animal, but is drawn to express, so to speak, the *possibilities of animal distribution* with relation to the distribution of the factors controlling the various types of animal life, in fact, it is an *ecological map of the continents.* For the reality of the divisions laid down upon this map examples are introduced, but, of course, only a limited space could be reserved for them.

The author insists that these relations of the organic world to their environment are of prime importance for the distribution of life upon the earth, and in this he certainly is right. But he also admits that the geographic history of the earth plays an essential part in this question. *The historical develop-*

ment of the present distribution of plants and animals, which is one of the most fascinating problems of recent biogeography, is not neglected by him. But he does not approach it from the biogeographical standpoint in so far, as he does not attempt to prove former geographical conditions by the present distribution of any organic forms, but makes it a part (chapter VIII., p. 577 ff.) of the physical geography of the land, and treats of it in connection with geological principles. His general account of the history of the continents and oceans, although given only in its main features, is rather good, and deserves attention. It rests chiefly upon the studies of the most prominent writers in this line (Suess, Lapparent, Frech, etc.).

Altogether we may say that the parts of this book discussed here are well worth reading. Difficult branches of scientific research, which are yet subject to much controversy, are represented in a lucid way, showing the cleverness and originality of the writer, and demonstrating also that he is well acquainted with the most modern phases of the questions discussed. It is hardly feasible to go into any detail, and to attempt a critical review of the special opinions of M. de Martonne, since in certain cases we would be compelled to offer evidence for the contrary, for which there is no room in these pages. We only would recommend this book to the study of all those who are interested in biogeography, ecology and paleogeography, and we have no doubt it will be a stimulus to them in their own work. These chapters are not so much a "text-book" for the beginner, giving a circumscribed amount of scientific facts to be stored away in the brain, and to be used at an "examination," but they are a challenge to the active, progressive worker in these lines, to scrutinize his own ideas, to revise them, and if they differ from those proposed here, to say so, and to bring forth the evidence, in order that they may be discussed according to their merits.

A. E. ORTMANN

PITTSBURGH,
March, 1910

Die Chemische Industrie. By G. MÜLLER. Pp. 488. Leipzig, B. G. Teubner. 1909. Price, bound, M. 12.

This book aims to aid the merchant in his calling and to serve as a guide in trade and technical matters for chemists and others engaged in the chemical industries.

The strictly chemical aspects of the subjects here discussed are relegated to another volume, "Chemical Technics" by Dr. Heusler, which has appeared in this same Teubner "Series of Trades and Industries," to which the work here considered belongs.

The author has divided his book into two parts.

Part I. is devoted to the General Survey of Chemical Industry, and includes a discussion of its scientific and technical evolution and of the laws of trade and commerce.

In Part II. the writer takes up individually many of the more important branches of Chemical Industry, among them acids, salts and alkalies, artificial fertilizers, explosives, aluminum compounds, mineral oils, dry distillation, the industries of coloring matters and colors, fats, oils, rubber and gutta-percha; a bibliography of German publications of technical hand- and text-books, a list of some technical journals, and a carefully prepared subject-index, conclude the volume.

A liberal introduction of tables of export and import of many of the chemical substances discussed permit an interesting study of the conditions of various trades in different countries, and at different times. Naturally, German conditions receive by far the largest share of attention, but it can not be said that the trade conditions of other countries have been neglected.

The different topics of child labor, working men's insurance, laws and regulations of hygiene in different industries, all receive consideration and the treatment of the various topics throughout shows an intimate acquaintance with the data and statistics of the subjects discussed.

The statistics generally include those of the year 1907, and are thus well up to date. Prices,

when they are quoted, seem to be given with scrupulous care, in illustration of which it may be remarked that the author quotes the price paid for matches in the United States per thousand, not boxed, and per gross of boxes containing 100 matches each.

The style in which the book is written is pleasant and lucid and, in general, the sense of proportion is well maintained. It does, however, seem strange that no mention whatever should have been made of the Sugar Industry, certainly one of the leading industries of the present day, when the author has found it desirable to refer to the industry of condensed gases, and to that of calcium carbide and acetylene gas, in some detail.

The paper and print are of the usual excellence of the Teubner publications.

F. G. Wiechmann

Schoenichen-Kalberlah. B. Eyferth's Einfachste Lebensformen des Tier- und Pflanzenreiches. Naturgeschichte der mikroskopischen Süsswasserbewohner. Vierte, vielfach verbesserte und erweiterte Auflage von Dr. Walther Schoenichen. Mit über 700 Abbildungen auf 16 Tafeln in Lichtdruck nach Zeichnungen von Dr. A. Kalberlah. Zahlreichen Abbildungen im Text und 2 Portraits. Braunschweig, Verlag von B. Goeritz. 1909. M. 23.60.

The fourth edition of Eyferth's "Einfachste Lebensformen" from the hands of Dr. Schoenichen brings up to date this old favorite of the amateur microscopist. The work is, however, somewhat more than a popular treatise on the microscopic life of fresh water, being a carefully worked out systematic manual of about 1,700 species. It covers the minute plant life quite completely and includes the Protozoa, Rotifera and Gastrotricha on the animal side. It is to be regretted, in the matter of completeness, that the remaining animal groups of fresh water, at least the Entomostraca, Nematoda, Annelida and Turbellaria, were not added in this revision. Such additions would very greatly enhance the usefulness of the work and might still permit its compass in a single volume. The excellent heliotype plates with their 700 figures from original sources such as Cohn, Fischer, Naegeli, Kirchner, Hansgirg, Rabenhorst, Wille, Van Huerck, Smith, Leidy, Schulze, Penard, Senn, Stein, Klebs, Schewiakoff, Hudson and Gosse and Weber afford a wealth and range of illustration rarely attained in inexpensive manuals. The great reduction in size has resulted in some loss of detail in the case of the plates of the Ciliata, but on the whole it has been adequately preserved elsewhere.

The fourth edition has been enlarged by a complete revision of the Chlorophyceæ, Mastigophora and Rhizopoda and many minor additions in other groups involving the insertion of a considerable number of text figures.

The introductory chapter deals with the œcology of the microscopic life of fresh water, its occurrence and distribution, methods of collection, examination and preservation, and the biological examination of potable waters. The last topic is, however, very inadequately treated, judged by the criteria of the sanitary engineer.

A few errors are to be found in the book; *e. g.*, the genus *Pleodorina* should be assigned to Shaw, and the plates of *Ceratium* are incorrectly described and figured.

There are also some noticeable omissions in the references to important literature, as, for example, the failure to mention the *Archiv for Protistenkunde* and under algæ the omission of West's "Desmids," Penard's "Dinoflagellata," of Chodat's and of Lemmermann's compendiums of Swiss and Brandenburg algæ. Sand's monograph of the Suctoria is not noted. No reference is made to Rousselet's methods for rotifers nor of Jennings's indispensable contributions to the more difficult families of this group.

The index is ample and accurate and the various organisms are, in part at least, classified here by a set of symbols according to their associations and œcological relations as polysaprobs, strong or weak mesosaprobs and oligosaprobs, after the conclusions of Kolkwitz and Marsson.

The book is a useful addition to the library of the laboratory, the water analyst and the amateur microscopist. CHARLES A. KOFOID

UNIVERSITY OF CALIFORNIA

Habit-Formation and the Science of Education. By STUART H. ROWE, Head of the Department of Psychology and Principles of Education in the Brooklyn Training School for Teachers, and Lecturer on Educational Psychology in Adelphi College, Brooklyn, New York. Pp. xvii + 300. New York, Longmans, Green & Co. 1909.

Educational doctrines, so far as they find expression in school practise, have been unseemly erratic. This is due to the fact that the scientific method has never been employed in solving school problems. Education is still an art, managed pretty successfully by those whose instincts are adapted to it, but wretchedly bungled by all others. The schools, like other social institutions, have followed the line of least resistance. During the colonial period, when the body of knowledge was comparatively small, when books were few, and society less complex, children were thoroughly drilled in the few subjects which they studied. With the rapid growth in knowledge and in the industries, during the latter part of the nineteenth century, new demands were made upon the schools. The three R's no longer met the social needs, and, with the enlargement of the curriculum, the drill master disappeared. The unscientific feature in this change is the entire absence of accurate analysis of the problem. A method that has been followed is not necessarily bad because of its age, nor is the new, because of its youth, good. It is this uncritical, mad dash from one method to another, during a time of prevailing scientific investigation, that has brought education into disrepute. Any book, therefore, that critically examines one of the educational problems, is a contribution to education. And this is what Rowe's "Habit-Formation" does. The teacher, Rowe maintains, interferes too much in the learning process of her pupils. She neglects "all the automatic (both natural and acquired) ways of learning which the child has, and insists that he work out everything systematically and under guidance." This is not only a useless waste of teaching energy, but, in addition, it disturbs the course of development. Every child has his own way of responding to his environment, because of his organic structure, and forced departure from this individual mode of reacting must be decided upon only after the most careful examination of the situation. Motor, visual and auditory minded children illustrate the need of care. Rowe discusses the manner in which experience is organized, and emphasizes the distinction between habits and ideas. "Determine whether the habit is an automatism which will be hit upon by the child as a result of his own initiative and experimental efforts, or implies a definite idea which must first appear in consciousness before it can be transformed into a fixed automatic process." In other words, the teacher is to adapt herself to the situation. She is to "analyze the subject-matter and determine what elements in it are to become habitual." The way in which habits are established, the manner of securing practise, and the method of evoking initiative, are treated in separate chapters. Initiative is to be developed through appeals to the instinctive activities, the emotions, and to specialized motives. Appeals to the child's reason are appeals *through* reason to his instincts, emotions or motives. Practise is to be secured by making "all the conditions such that the reaction will take place as naturally as possible." Teachers have been too willing to work against the resistance of the instincts and emotions. This is because, at the outset, it is the line of least resistance, and failure to analyze the situation causes them to overlook the fact that later it becomes the line of greatest resistance. One of the purposes of education is to establish mental attitudes toward the various subjects of study and toward work in general, and Rowe deals at length with the various kinds of drill in relation to this purpose. The difficulty with the book for teachers who are unskilled in psychology is that it lacks concreteness. Illustrative examples are not as numerous as they should be, but this is a less serious objection

than it would have been a few years ago, and altogether the book is a valuable contribution to the science of education. A useful bibliography is appended.

Edgar James Swift

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St. Louis, Mo.

NOTES ON THE TEACHING OF ZOOLOGY AND PLANS FOR ITS IMPROVEMENT

Few Elect Zoology.—Although for some time the writer has been under the impression that a good many more students elect botany than zoology, both in the high schools and academies and in the college; yet in glancing over our (Kansas) "High School Manual"[1] I was somewhat surprised to find that almost *eight* times as many high school pupils were last year enrolled in botany as in zoology—to be exact, 2,669 in botany and 346 in zoology. Another table in this manual reveals the fact that while 177 of the accredited high schools claim to be equipped for botany, but 33 claim any equipment for zoology, and the latter is usually estimated at a lesser value. I can quote figures from one other state only. In Minnesota,[2] starting with a ratio of 4 to 1 in 1894, zoology has steadily gained till last year it stood 9 to 7 in favor of botany. The fact that neither St. Louis, Mo., nor Tacoma, Wash., offers any zoology in its high schools leads me to suspect that similar disproportion exists in other states, at least in the middle and far west.

We teachers of zoology can not avoid asking, Why is this so? It is surely not because animals with their free movements and their intelligence are less interesting than plants. Where is the child or grown-up (aside from the specialist) who will not leave the prettiest bed of flowers to watch the cage of playful monkeys? The moving object, particularly the automatically moving one, attracts all of us. Nor can it be that the school authorities regard zoology as less practical than botany. To know the ravaging insect is just as important as to recognize the medicinal plant. To name the brilliant song bird properly is just as desirable as to classify the fragrant flower.

According to my thinking, at least three causes can be cited which operate to bring about such a disproportion between the subjects.

The first one is the lack of properly prepared teachers. Few of the instructors in the high schools are prepared to teach either of the two sciences. When called upon to teach one, a majority will choose botany instead of zoology. They probably had a course in elementary botany and not in zoology. Besides, plants are simpler and they feel that they can manage a course concerning them better than the more complex and larger group of animals.

A second and probably a more potent cause is the fact that many of our children are taught by their parents from early childhood to avoid and fear the animals—the creepy worms, the biting spiders and the dreadful mice. In "nature study" in the grade schools (taught by women) this view of the animals is farther inculcated. As a result, when the young people get into the high school and are to select a biological science they naturally choose botany.

The third cause is a greater one, at least a more real one. It is the difficulty of securing plenty of good material for the course in zoology. While the botanist has all his important phyla represented in almost any inland region, the zoologist has three important phyla practically limited to salt water. This necessitates the securing of a good deal of material from the seashore. And of the material that is in the vicinity it is so much easier for the botanist to secure what he wants—to pick the flower on the bank of the brook than to catch the cray-fish in the dirty water. The flower will surely be found on the first "tramp," provided it is made at the right time and to the right place. To secure the cray-fish, in addition to choosing the right season and the proper locality, the necessary seine or other paraphernalia to catch the desired specimen must be taken along. Sometimes it means the employment of help to handle the apparatus. To secure some species requires a different set of tools, and they are even harder to get than

[1] *Bulletin of the University of Kansas*, 1908.

[2] Fifteenth Annual Report of the Inspector of the State High Schools. State of Minnesota, 1908.

the cray-fish. After the material has been brought to the laboratory it needs to be killed and preserved by proper methods. All this means more trouble than the ordinary high-school teacher wants to or has time to take.

It is true some specimens can be bought; and matters are rapidly improving as more collectors are selling zoological supplies; yet not all the things needed are on the market. Many of those who would teach zoology do not know where to buy. The cost, which is considerable, hinders some. Besides, teachers feel that a good many local forms should be studied, and this is true especially in the high school. But where and how shall they be secured?

University a Distributing Center.—To answer the last question and encourage zoology teaching over the state the department of zoology in the University of Kansas has decided to become a central supply station for the secondary schools of the state. Many of the standard type-forms have been purchased in larger quantities than needed for the department's own use. A good deal of local collecting has been done; besides, two expeditions have been taken, one to the Gulf Coast in 1908, and one to Puget Sound in 1909. On both of these trips, but especially the latter, large quantities of material were secured for class use. This has been carefully prepared and preserved for dissection and demonstration. All these collections put the department in shape to supply all the necessary material to the secondary schools. A preliminary list of what can be furnished has been sent to the schools. Prices are very low, because of the excellent collecting found on the coast of Puget Sound, and because the plan of the department is not to make money out of the venture, but to get more zoology taught. So as not to discourage small schools, small orders are sold at nearly as low prices as larger ones. The result of the whole plan is and will continue to be to encourage and improve greatly the zoology teaching in our preparatory schools.

"Problem Solving."—The writer believes that one important thing in teaching is to get the student to "solving problems." Professor Alexander Smith has recently emphasized this very much in the columns of this JOURNAL.[3] With this in view the writer has for five years assigned to every member of the classes in the second and third courses in zoology one major problem to be worked out and reported on before the class. The question to be reported on was always so chosen that it could not be answered from any book, but required independent dissection and observation. The subject was assigned early in the semester so that the student had ample time to work it out in addition to the daily work in the class room. This has always given satisfactory results.

During the last two years our department has used in elementary zoology such a scheme of "problem solving" that seems to me to be worthy of a trial by other teachers. Our elementary classes are large, running from 75 to 100 or more students. After the type form for the phylum or class is done other species of the group are classified by the student as far as the order. For this purpose we have regular sets of bottled and numbered specimens which are given to a small section of the class and these students classify them, giving the reason for, or the characteristic used in, every determination. Similar sets are being prepared for the high schools, either to be sold or loaned to them.

After all the principal phyla have been studied every student, as far as possible, is given a different animal. He finds out what the specimen is, dissects it, makes drawings of it and in short finds out all he can about it, and then reports his findings to the rest of the class. As most of these specimens are but briefly if at all described in the usual texts used, the problem is a real one to the student. He is urged and must of necessity get first-hand knowledge by comparing his specimen with the forms already studied. Only after he has found all he can is he guided to additional literature. By this plan the student solves a real problem. He learns to notice in a new way how the "types" are treated in the text-books so as to get a plan for the arrangement of his own material. This plan must be approved by one of the instructors before the report can be given to the class. While one stu-

[3] SCIENCE, N. S., XXX., p. 459.

dent reports the rest take notes, just as they do when the instructor lectures. At the end of each report questions are asked and corrections are made. The notes taken by the rest of the students are corrected by the one who gives the report, and are bound up with the students' general note-book for the course. The one reporting binds up his outline, and a list of the books and papers consulted—a bibliography.

By this plan the student learns much about one animal not treated in the texts and he learns a little about a good many other species. But he does more—*he gets a training in using the powers of observation, in ordering the facts obtained and in expressing to others the knowledge gained.*

The two main suggestions are worth a trial by other teachers. The university should encourage the teaching of zoology by becoming a center for furnishing and distributing the material for the preparatory schools of a state at cost. Much of this could be secured very cheaply by a collecting expedition to Puget Sound. The student should be given the problem of furnishing the rest of the class with a report dealing with a special form of animal life somewhat closely related to a type studied. This working out of a "lecture?" by the student is the best of training for him.

W. J. Baumgartner

SPECIAL ARTICLES

AN EXPRESSION FOR THE BENDING MOMENT AT ANY SUPPORT OF A CONTINUOUS GIRDER FOR ANY NUMBER OF EQUAL SPANS

Tables giving the bending moments at the supports of a continuous uniformly loaded girder with equal spans are found in most of the books on strength of materials, but these tables usually stop at six or seven spans. The object of this paper is to give a general expression from which the bending moment at any support for any number of spans can be computed. First the expression and explanation of the method of computation are given and then follows the derivation of the formula.

Let M_1, M_2, $\cdots$ be the bending moments at the first, second . . . support, respectively. Let n be the number of spans, w the load per unit length and l the length of span. If M_r represents the bending moment at the rth support then the formula gives

$$M_r = -\frac{\Delta_{r-2}D_{n-r+1} - D_{r-2}\Delta_{n-r}}{2\Delta_{n-1}} wl^2.$$

The Δs and Ds are numbers to be computed from the formulas.

$$\Delta_n = 4\Delta_{n-1} - \Delta_{n-2},$$
$$D_n = \Delta_{n-1} - D_{n-1}.$$

As shown below, $\Delta_0 = 1$, $\Delta_1 = 4$ and $D_0 = 0$ and any other Δ or D may be easily computed. For example,

$$\Delta_2 = 4\Delta_1 - \Delta_0 = 15,$$
$$\Delta_3 = 4\Delta_2 - \Delta_1 = 56,$$
$$\cdots\cdots$$
$$D_1 = \Delta_0 - D_0 = 1,$$
$$D_2 = \Delta_1 - D_1 = 3.$$

Thus, if, for example, we wish the bending moment at the fourth support for seven spans, we have $r = 4$, $n = 7$ and

$$M_4 = -\frac{\Delta_2 D_4 - D_2\Delta_3}{2\Delta_6} wl^2.$$

From the above formulas $\Delta_2 = 15$, $D_4 = 44$, $D_2 = 3$, $\Delta_3 = 56$, $\Delta_6 = 2911$. Hence

$$[M_4]_{7\text{ spans}} = -6/71\, wl^2,$$

a result which is verified by the tables.

The derivation of the above formula is nothing but the general solution of the equations of three moments by determinants. For n spans we have, from the theorem of three moments,

$$M_1 + 4M_2 + M_3 = -wl^2/2,$$
$$M_2 + 4M_3 + M_4 = -wl^2/2,$$
$$\cdots\cdots$$
$$M_{n-1} + 4M_n + M_{n+1} = -wl^2/2.$$

Since $M_1 = M_{n+1} = 0$ we have left $n-1$ equations with $n-1$ unknowns. If we write 1 in place of $-wl^2/2$ and multiply the final result by $-wl^2/2$ the solution will be less complicated. Writing the Ms with the same subscripts under one another we have

$$\begin{aligned} 4M_2 + M_3 \qquad\qquad &= 1, \\ M_2 + 4M_3 + M_4 \qquad &= 1, \\ M_3 + 4M_4 + M_5 &= 1, \\ \cdots\cdots\cdots\cdots & \end{aligned}$$

The determinant of the system of equations will be the determinant,

$$\begin{vmatrix} 4 & 1 & 0 & 0 & 0 & \cdots \\ 1 & 4 & 1 & 0 & 0 & \cdots \\ 0 & 1 & 4 & 1 & 0 & \cdots \\ 0 & 0 & 1 & 4 & 1 & \cdots \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdots \end{vmatrix}$$

of order $n-1$. We will represent it by Δ_{n-1}. The solution of the system of equations for any unknown, say M_r, will be a fraction with Δ_{n-1} for the denominator. The numerator of the fraction will be a determinant of order $n-1$ with the same elements as Δ_{n-1} except that each element in the $r-1$th column is 1. By expanding Δ_{n-1} it is easy to see that the general formula

$$\Delta_n = 4\Delta_{n-1} - \Delta_{n-2}$$

holds. Since $\Delta_1 = 4$ and Δ_0 may be defined as 1, any Δ may be computed.

For computing the determinant in the numerator we let D_n represent a determinant of the nth order which has the same elements as Δ_n except that each element of the first column is 1. Expanding D_n, it is found that

$$D_n = \Delta_{n-1} - D_{n-1}.$$

D_0 is to be defined as 0. Now expanding the numerator of the fraction representing M_r in terms of minors of the upper $r-2$ rows, we find

$$M_r = \frac{\Delta_{r-2}D_{n-r+1} - D_{r-2}\Delta_{n-r}}{\Delta_{n-1}},$$

and multiplying this result by $-wl^2/2$ we have the general expression given at the beginning of this article. In computing a table from this formula it is of course not necessary to compute all the Ms, for the bending moments at supports equidistant from the ends are equal, that is,

$$M_r = M_{n-r+2}.$$

Arthur R. Crathorne
University of Illinois

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The sixtieth regular meeting of the society was held at the Ebbitt House, February 19, 1910, at eight o'clock P.M.; President Wm. A. Taylor presided. The following papers were read:

Sprout Leaves of Western Willows: C. R. Ball, U. S. Bureau of Plant Industry.

A knowledge of the range of variation in the leaves of willows is important because a large proportion of the herbarium material must be determined from foliage specimens only. This is due to the precocious flowering of many species and the quick disappearance of the staminate aments from all, thus leaving fully half the plants in this diœcious genus with only the leaves as determining features. The pistillate aments also are gone from plants of the diœcious species before most collectors reach the field. The leaves of the so-called water sprouts are interesting because of their wide departure from the normal, especially in size and to some extent in form also.

A series of collections shows that the proportion of breadth to length found in the normal leaves is maintained in sprout leaves from the same individual in several species of the sections Pentandræ, Longifoliæ and Cordatæ from the western United States. A variation of form was found in a specimen of *S. scouleriana* (section Capreæ) from Arizona, in which the normal leaves are obovate, but those of this sprout were broadly ovate. The paper was illustrated by numerous specimens.

Bull-horn Acacias in Botanical Literature, with a Description of two new Species: W. E. Safford, U. S. Bureau of Plant Industry.

There has been much confusion as to the identity of certain acacias of Mexico and Central America having large inflated horn-like stipular thorns, which are usually inhabited by ants. Linnæus placed all which had been described previously to the publication of his "Species Plantarum," under a single species *Mimosa cornigera.* Schlechtendal and Chamisso recognized the fact that the supposed synonyms cited by Linnæus included more than one species. These authors described two species found in the collections of Schiede from the state of Vera Cruz, Mexico, which they named *A. spadicigera* and *A. sphærocephala.* They leave it in doubt whether either of these species is the *Arbor cornigera,* figured and described by Hernandez (ed. Rom., p. 86, 1656), which in all probability is identical with the first plant cited by Linnæus, under his description of *Mimosa cornigera.*

In the National Herbarium are specimens of a bull-horn acacia from the type region of Hernandez's plant, collected by Dr. Edward Palmer. There are also at least two others quite distinct from any species hitherto described, one of them from Guatemala, with the inflorescence in spherical heads and with very long slender dehiscent pods; the other from the state of Chiapas, southern Mexico, with spadix-like inflorescence and

stout dehiscent pods. *Acacia cornigera* L. differs from both of these in having inflated indehiscent pods terminating in a spine-like beak, as well as in the character of its inflorescence and of the extrafloral nectaries on its leaves.

Acacia cookii sp. nov. Flowers in spherical heads on long stout peduncles clustered in the axils of large slender thorns resembling the prongs of a fork which usually straddle the stem; leaves large, with many pairs of pinnæ and many elongated nectar glands borne on the upper side of the grooved rachis; pods linear, 30 cm. or more in length, slightly curved, dehiscent. Based on specimens collected by Mr. O. F. Cook at Secanquim, Alta Verapaz, Guatemala (in alcohol), and by Mr. G. P. Goll, at the Finca Trece Aguas, in the same region, March 8, 1907 (No. 102).

Acacia collinsii sp. nov. Flowers in spadix-like spikes, usually in clusters of four or five, the oldest spike usually sessile or nearly so, the rest on long stout peduncles; bractlets of the inflorescence peltate circular, covering the unopened flowers, but concealed after anthesis; leaves with several round bead-like nectar-glands at the base of the petiole and a single gland on the rachis at the base of each pair of pinnæ; thorns stout, U-shaped; one of the arms usually perforated by ants, as in the case of other "bull-horn" acacias; pods stout, thick, short, straight or slightly curved, dehiscent, filled with yellow sweetish aril in which the seeds are imbedded. This species is based on specimens collected by Mr. Guy N. Collins between Chicoasen and San Fernandino, in the state of Chiapas, southern Mexico, January 14, 1907 (No. 180). A species resembling *Acacia hindsii*, but differing from that species in the form of its thorns, the thickness of its peduncles, and the form and stoutness of its pods.

The Categories of Variation: W. J. Spillman, U. S. Bureau of Plant Industry.

Recent work indicates that the variations with which Darwin dealt may be separated into several categories which have different relations to evolutionary change. The work of Nilsson, Johannsen and Jennings seems to have demonstrated that there is a class of variations, due wholly to environment, that are not hereditary and on which selection is without effect. These variations are coming more and more to be called "fluctuations."

It is also pretty well established that when an organism is removed from its old environment to an entirely new one it may undergo rather marked changes, apparently as the result of changed environment. The meager information at hand indicates that several individuals having exactly the same inheritance undergo the same change when transplanted to a new environment and that the change is permanent under the new environment. Some recent investigations indicate that in cases of this kind, when the organism is transferred back to its old environment, it changes back to its old form. Much more investigation is needed before this type of variation, which is sometimes called "new-place effect," can be properly catalogued.

A third type of variation is that due to recombination of Mendelian characters. These recombinations frequently result in the production of new forms which are stable and must therefore be looked upon as one means of progressive evolution.

Apparently a fourth type of variation is that discovered by de Vries in *Œnothera*. The investigations of Gates and Miss Lutz point to the assumption that the variations studied by de Vries are due to the loss, gain or exchange of chromosomes in mitosis.

There are probably many other types of variation which have not yet been recognized. On *a priori* grounds it would appear almost certain that changes in the chemical composition of the germ plasm or in the relative amounts of substances present in the germ plasm are of fundamental importance in evolution, and that in the main evolutionary progress is due to them. These changes may take place in any part of the germ cell which has a determining influence on development. It was suggested that when such a change occurs in the composition of a chromosome the new form resulting would give Mendelian phenomena when crossed with the old form, but if the change occurs in cytoplasm Mendelian phenomena would be lacking, and there is some evidence that this is the case. A case in point is that of albomarginate leaves studied by Baur. The behavior of the cross is such as to indicate that the albomarginate character is cytoplasmic, and the inheritance of this character is non-Mendelian.

W. W. Stockberger,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 445th regular meeting, held March 29, 1910, the first paper of the evening was on "The White-dog Feast of the Iroquois," by Mr. J. N. B. Hewitt.

The white-dog sacrifice of the Iroquois is a

congeries of independent rites, ritually interrelated at this ceremony, designed to renew through the orenda or immanent magic power of these rites the life powers of living beings, the fauna and flora of nature, which are ebbing away to their extinction by the adversative action of the powers of the winter god. The embodiment of all life is Teharonhiawagon, or the "Master of Life." One of the functions of a tutelary is to reveal in a dream what is needful for the restoration of the life force of its possessor. The tutelary of Teharonhiawagon reveals to him in a dream that a victim, primarily a human being but symbolized by a dog in modern times, with an offering of native tobacco, would restore the life forces which he embodies, and with a performance of all the sacred rites of the people at this time for the purpose of disenchanting all his aids and expressions—the bodies and beings in nature. These rites therefore seek to compel the return of the sun, the elder brother of man, to the north from his apparent departure southward. The rites performed at this new year ceremony are the rekindling of new fires on the hearths of the lodges, the disenchantment of individuals by passing through the phratrial fires lighted in honor of Teharonhiawagon in the assembly-hall, the rechanting of the challenge songs of individual tutelaries to rejuvenate them, the "divining of dreams" for the restoration of the health of individuals, and for the purpose of ascertaining the revealed tutelaries of persons and children who have no tutelaries, the sacrifice of a victim to restore the health of Teharonhiawagon, and finally the performance of the four ceremonies of the tribe, the latter consuming the better part of four days in their performance. Such is in brief the ceremony of the Iroquois Onnonhwaroia, or new-year festival.

The second paper was presented by the president of the society, Dr. J. Walter Fewkes, on "The Return of the Hopi Sky-god."

The Hopi, said the president, shared with many other tribes of North American Indians, the idea of an annual return in spring time of a sky-god to revivify the earth. This conception, which is wide-spread among the pueblos, accounts in part for the belief in a future advent of Montezuma, or a fair-god, and explains certain ceremonial representations prominent in sun worship. It is so deeply rooted in Hopi myths that we find the return of the sky-god dramatized by a personation of this being accompanied by elaborate rites. From the composite nature of the Hopi ritual, dramatizations of this advent are duplicated, varying somewhat in detail, although remaining the same in general intent.

The sky-god is regarded by these Indians as the god of life, who by magic power annually rejuvenates the earth, thus making possible the germination and growth of crops which furnish the food supply of the Hopi. Some variants of this drama are performed at Walpi in late winter; others in early spring. One of the several presentations, mentioned by Dr. Fewkes, was the personation of the sky-god which occurs about Easter in a complex drama called the Powamu. The main object of this ceremony is to discharm or disenchant the earth which throughout the winter is supposed to have been controlled by a malevolent being. In this ceremony the sky-god, under the name of the returning one, is supposed to lead his followers, the clan ancients, or Kachinas to the pueblo, fructifying the earth and thus bringing back the planting and much-desired harvest time. Clad in prescribed paraphernalia, the personator of the sky-god, wearing the mask of the sun, enters the pueblo at sunrise from the east, and proceeding to every sacred room and clan house, receives the prayers of the owners of the dwellings, for abundant crops, giving in return, as symbols of a favorable reply, sprouting corn and beans. As he does so he marks each doorway with sacred meal and bowing to the rising sun, beckons to his imaginary followers to bring blessings to the people—blessing always being abundant crops and copious rains.

Certain clans now living in a pueblo near Walpi called Sichumovi, whose ancestors claim to have originally come from Zuñi, celebrate the return of their sky-god with slight variations, but with the same intent. The symbolism which distinguished the personators of the sky-god and his followers in this pueblo was brought by clans from Zuñi several years ago. Other clans that according to legends migrated to Walpi from southern Arizona perform a characteristic dramatization of the return of their sky-god, the advent of which occurs at the time of the winter solstice. Here the personator of the sky-god represents a mythic bird, whose realistic return is dramatized in the kiva or sacred room. At sunrise on the following morning, accompanied by two corn maidens, the sky-god, no longer a bird personator, distributed seed corn to representatives of the clans of the pueblos.

The ceremonies accompanying the return of the sky-god at the winter solstice are many and com-

plicated. Some of these are designed to disenchant the earth, while others draw to the pueblo the gods of germination. The prayers are said to the plumed serpent, represented by an archaic effigy, to fertilize the earth. A personation of the sky-god carrying the effigy of the plumed serpent, emblematic of lightning, forms one act of the great theatrical ceremony in the month of March; this act is performed at night in the kivas in the presence of the whole population of Walpi and neighboring villages, and represents the return of the sky-god, and the renewal of life on the earth made dormant by the sorcery of evil-minded gods.

I. M. Casanowicz,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 468th regular meeting of the society was held March 19, 1910, in the main hall of George Washington University, with President T. S. Palmer in the chair and a good attendance of members. Sixteen new members were elected.

Under the heading brief notes and exhibition of specimens Professor W. J. Spillman exhibited specimens of hoofs and foot bones of the solid-hoofed, or mule-footed, hog, a breed now well established but by no means new, since it was known 2,000 years ago.

H. W. Clark reported that he had observed numerous birds and insects feeding on sap that had oozed from a wounded spot on a red-oak tree. Among the birds were the humming bird, woodpeckers and flycatchers.

The following communications were presented:

The Birds of Midway Island: Paul Bartsch.

This paper was illustrated with photographs and specimens to show the use of the McIntosh reflectoscope.

The International Fisheries Regulations: Barton W. Evermann.

The paper by Dr. Bartsch was discussed by President Palmer and others; that of Dr. Evermann was also discussed by the president.

The 469th regular meeting of the society was held April 2, 1910, in the west hall of George Washington University, with President Palmer in the chair.

Under the heading brief notes, Dr. C. Dwight Marsh reported the receipt of some interesting copepods from Dr. V. L. Shelford, of Chicago University. Among them was the species *Diatomus Righardi*, obtained from northern Lake Michigan.

President Palmer reported that Professor John B. Watson, of Johns Hopkins University, would act as warden of the Tortugas Bird Reservation during the present season, and under the auspices of the Carnegie Institution would continue his investigations of the homing instincts of the noddy and sooty terns. These birds, carefully marked, will be carried farther north on the Atlantic coast and inland than in former experiments and also to the north and west sides of the Gulf of Mexico with a view to determining the length of time in which they find their way back to the nesting grounds.

The following communication was presented:

A Hasty Visit to some Foreign Zoological Gardens (illustrated with slides): A. B. Baker.

Mr. Baker's recent visit to Nairobi, Africa, to bring home the animals presented to the National Zoological Park by Mr. W. N. McMillan, afforded an opportunity to visit some of the foreign zoological gardens. Brief visits were made to those at Manchester, London, Antwerp, Rotterdam, Amsterdam, Berlin, Halle, Frankfort, Hamburg, Leipzig, Breslau and Vienna in Europe and to the Gizeh gardens in Egypt. A description of the grounds and buildings was given. The illustrations were mainly from ordinary picture post cards, thrown on the screen by a reflectoscope.

D. E. Lantz,
Recording Secretary

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

The thirty-seventh meeting was held at the Physiological Laboratory of the New York University and Bellevue Hospital Medical College on Wednesday, February 16, 1910, at 8:15 p.m., with President Lee in the chair.

Members Present: Atkinson, Auer, Banzhaf, Cole, R. I., Flexner, Gies, Hiss, Jackson, Joseph, Lee, Levin, Lusk, Mandel, A. R., MacCallum, McClendon, Meltzer, Morgan, Morse, Opie, Park, Rous, Shaklee, Stockard, Van Slyke, Wallace, Weil.

Officers elected: President—Dr. T. H. Morgan; *Vice-president*—Dr. W. J. Gies; *Secretary*—Dr. E. L. Opie; *Treasurer*—Dr. Graham Lusk.

New members elected: Dr. J. V. Cooke, Dr. A. R. Dochez, Professor J. B. Leathes.

Scientific Program

"A New Method for Determining the Activity of Ferments and Antiferments," R. Weil and S. Feldstein.

"Resistance to the Growth of Cancer Induced in Rats by Injection of Autolyzed Rat Tissue," Isaac Levin.

"Parenteral Protein Assimilation," P. A. Levene and G. M. Meyer.

"The Inhibitory Effect of Magnesium upon Indirect and Direct Irritability of Frog Muscle and the Antagonistic Action of Sodium and Calcium upon this Effect," Don R. Joseph and S. J. Meltzer.

"On the Vaso-motor Nerves of the Stomach," R. Burton-Opitz.

"The Change in the Venous Blood-flow on Administration of Amyl Nitrate," R. Burton-Opitz and H. F. Wolf.

"The Fate of Embryo Grafted into the Mother," Peyton Rous.

"The Behavior of Implanted Mixtures of Tumor and Embryo," Peyton Rous.

"Vaughan's Split Products and Unbroken Protein," Edwin J. Banzhaf and Edna Steinhardt.

"Notes on Sensitization with Tuberculin to Tubercular Rabbit's Serum," J. P. Atkinson and C. B. Fitzpatrick.

"Remote Results of the Replantation of the Kidneys," A. Carrel.

"Temporary Diversion of the Blood from the Left Ventricle to the Descending Aorta," A. Carrel.

"Remote Result of the Replantation of the Spleen," A. Carrel.

"The Mechanism of the Depressor Action of Dog's Urine with Remarks on the Antagonistic Action of Adrenalin," R. M. Pearce and A. B. Eisenbrey.

"On the Elimination of Bacteria from the Blood through the Wall of the Intestine," Alfred F. Hess.

EUGENE L. OPIE,
Secretary

THE AMERICAN CHEMICAL SOCIETY
RHODE ISLAND SECTION

A SPECIAL public meeting of the section was held in Rhode Island Hall, Brown University, on the evening of March 4, 1910, at 8 o'clock.

Professor Charles E. Munroe, dean of the graduate department of George Washington University, Washington, D. C., and consulting expert for the United States government at the Pittsburg Testing Station, Pittsburg, Pa., gave a stereopticon lecture on the subject "The Testing of Explosives for Use in Coal Mines, with special reference to the Prevention of Mine Disasters."

The lecturer first called attention to the enormous increase in the production of coal in the United States and then, in the discussion of the casualties attending coal mining, pointed out that whether the comparison was made on the basis of output or on the basis of the number of men employed, the loss of life was greater in the United States than in European countries. In 1907, under the auspices of the United States Geological Survey, an investigation was begun at the George Washington University to determine the reason for the difference. It was found, he said, that a reason lay in either the improper use of explosives or the use of improper explosives. While the university's investigation was being carried on, a series of serious disasters occurred at the Monongah mines, West Virginia, the Darr and Naomi mines in Pennsylvania and the Yolande mine in Alabama, in which 623 men were killed. These mine horrors aroused public opinion to such an extent that a suitable appropriation was made for an experimental inquiry into the nature of the explosives offered for use. A well-equipped testing station was opened on the arsenal grounds at Pittsburg, Pa., and since that time testing of explosives has been carried on with a view to determining which is most suitable for use in coal mines. After testing these explosives to determine the power and sensitiveness of each, in comparison with a certain grade of dynamite, which is taken as a standard, charges of known weight are fired, by detonation, from a very strong gun, into a mixture of natural gas, such as occurs in coal mines, and air, or natural gas, coal dust and air, or simply a mixture of coal dust and air, which mixtures are confined in a long cylindrical gallery made of boiler plate, to ascertain whether or not the charge of explosive when fired will cause the explosion of the mixture in the gallery. The gallery represents a gallery in the mine, and the hole in the gun represents the bore-hole in the coal in the mine. A limit charge of explosive is fixed upon, and if this quantity of explosive causes an explosion in the gallery, the explosive is rejected, but if it does not cause an explosion, the explosive is styled a permissible explosive, and is recommended for use. Since the establishment of the testing station at Pittsburg, 171 different explosive substances have been tested, and of these 51 have been put upon the list of permissible explosives.

ALBERT W. CLAFLIN,
Secretary

PROVIDENCE, R. I.